MILITARY SYSTEMS DESIGN

JANUARY-FEBRUARY 1960

featuring:

Actuators

Microwave Transmitters

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George at the Forge

The day the mobile radar was delivered to Washington at Valley Forge, it was so cold a man's shadow froze to the ground. Nevertheless, the Father of his Country managed to work up a good head of steam when he saw the unit.

*"Idiots!" he stormed. "Why do they send me radar when we need food and shelter and clothing? What good is it? Does it have Bomac tubes?"**

"No sir," his orderly shivered. "It doesn't seem to have any tubes at all. But it might make a nice warm fire."

"I was thinking the same," Washington said. And, without another word, he went and got a little hatchet and chopped and chopped. The wind blew and the chips flew. Soon, the installation was reduced to kindling.

"That's more like it," the General said when he was done. "Now, if someone will hand me a match . . ."

But he never finished the sentence. The ice on which he was standing suddenly gave way, and he disappeared into the frigid water.

"General, general are you all right?" the orderly asked as he fished him out.

"I'm afraid so," Washington said. "But you'd better put a sign here to warn the others."

So, that was why the famous sign was put up — the sign you can see today when you visit Valley Forge. You know the one.

It reads "George Washington slipped here."

* *Bomac makes the finest microwave tubes and components either side of Valley Forge.*

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MSD
MILITARY SYSTEMS DESIGN

VOLUME 4, NUMBER 1
JANUARY-FEBRUARY 1960

EDITORIAL

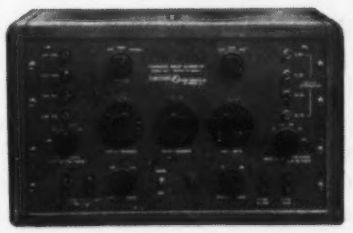
ARTICLES EMPHASIZING MICROWAVE TRANSMISSIONS

ARTICLES EMPHASIZING ACTUATORS

OTHER ARTICLES IN THE FIELD OF SYSTEM DESIGN AND COMPONENTS

REGULAR FEATURES

NOW
rapid analysis of recorder frequency response
20 cps-200 kc



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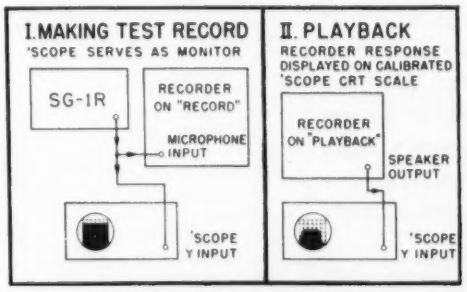
- Much faster than point-by-point methods.
- One cps repetition rate permits easy synchronization with many oscilloscopes, e.g. H-P #150A, DuMont #304 and #401. We will supply oscilloscope if desired.
- Internal frequency markers speed set up and insure accuracy.
- Precise enough for lab use.
- Simple enough for production test.

Plots recorder's relative amplitude response vs. frequency on oscilloscope screen. Trace repeats each second.

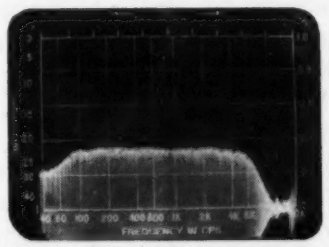
An optional version of the versatile Model SG-1, this new panoramic Sweep Generator combines the sweep signal with a synchronizing pulse. Sweep frequency test records are made using SG-1R. Calibrated CRT screen furnished.

SG-1R features include

1. Separately adjustable swept signal pulse outputs. 1 volt rms signal with 75 db attenuation. 4 volt peak pulse reducible to zero.
2. Two log sweeps: 40 cps-20 kc and 400 cps-200 kc. Linear sweeps: Any linear segment adjustable within 20 cps to 200 kc range may be selected.
3. SG-1R log amplifier provides 40 db calibration in addition to linear amplitude calibration.
4. SG-1R may be used as normal SG-1 sweep generator for tests of filters, amplifiers, etc. Sawtooth output drives oscilloscope H axis in such applications.



Block diagram shows recorder test set-up with oscilloscope and SG-1R.



Visual plot shows frequency response of tape recorder upon playback of test record using SG-1R Log sweep; 40 cps to 20 kc.

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MSD editorial

Crossroads at the Sixties

IMMEDIATE business prospects for the suppliers of Military Electronics Systems and components appear bright, according to many analysts of the President's budget message. Although the initial figure proposed for the military budget is held at last year's budget of about $41 billion, curtailments in some conventional arms and manned aircraft will enable a larger proportion of the appropriation to go to missile and space programs, in which the electronics industry will receive a larger share. The figure most quoted for electronics and associated programs, including development and research, is about $6.6 billion, to which must be added much of the NASA budget of $800 million for "non-military" space projects.

1960 appears to be shaping up as a year in which fateful decisions affecting the Nations future, perhaps for all time to come, will be made. Some particularly favorable trends are noted.

We are glad to note that the need for a continuing capability in conventional weapons is recognized in the President's budget. The capability to cope with limited disturbances and "brush fires", even to engage if necessary in limited wars, must be retained on an operational level. If this capability is lost, our adversaries then know that in a minor crisis we must either capitulate or initiate a nuclear conflict.

In line with freedom of choice in the instrument of national policy, we are encouraged to note that all services are awake to the advantage of mobile launching systems: Polaris for the Navy; the SAC airborne alert; and the Army's proposal for roving ICBM batteries mounted on railway cars. The mobile trend thus appears to reverse a tendency toward static missile bases that was disturbingly reminiscent of the Maginot Line.

However, the direct and most obvious answers to the Russian push for world supremacy are receiving the major attention of the appropriating powers. Equally as important in the long run, may be the effective measures to improve the number and quality of research scientists and engineers, because in one area after the other our technology is already pressing the frontiers of basic research. New materials, new techniques, new ideas are needed which cannot be produced other than by men of exceptional ability, provided with the op-

NOW! A NEW CONCEPT IN COMPUTER DESIGN SETS A NEW STANDARD OF VERSATILITY AND VALUE!

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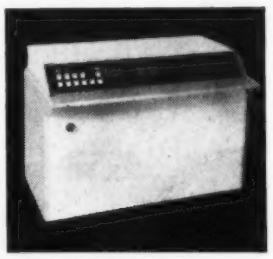
Wide range of applications: the RPC-4000 has been designed for engineering, scientific, business data processing and management control functions. Such jobs as product and process design, statistical analysis, research, inventory control, payroll and sales analysis are all well within its capabilities.

Easy to use: the RPC-4000 is simple to program and operate. Royal McBee compiling and translating routines allow even non-technical personnel to obtain maximum results. Versatile command structure gives programming speed and flexibility.

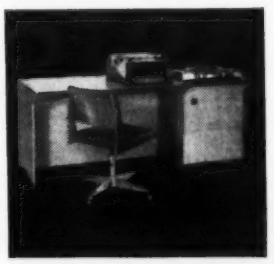
Available at low cost: high capacity, flexibility and ease of operation make the RPC-4000 the outstanding computer value on the market today.

Minimum operating costs: the RPC-4000 requires no site preparation or special maintenance. It is powered from any ordinary wall outlet.

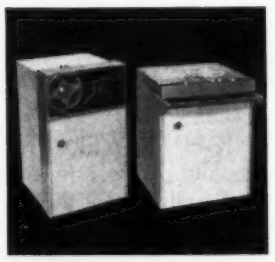
Continuing assistance: users benefit from free training, an information exchange service, and library of programs.



Heart of the RPC-4000 system is a new transistorized computer with advanced design concepts that provide substantial computing speed and capacity in a low-cost unit. Magnetic memory drum stores *8008 words*. Operating speeds are as high as 230,000/minute.



Standard input-output is a tape typewriter system which includes a Royal electric encoding-decoding typewriter complete with desk and chair, plus a tape punch-read console. Read speed is 60 characters/sec., punch speed 30 characters/sec. Typewriter, punch and reader may be interconnected in any combination for both on-line and off-line operations.



A new 500 character/sec. photoelectric tape reader and a 300 character/sec. punch are available as optional input-output equipment. A magnetic tape unit and a line printer will be available soon. As many as 17 input-output devices (60 with minor modification) may be connected on-line to the basic system. All peripheral equipment is under automatic program control of the computer.

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Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. RPC-4000 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing Offices. For full, detailed specifications on the new, transistorized RPC-4000, write **ROYAL McBEE** data processing division, Port Chester, N.Y.

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portunity, incentive and the time to achieve these breakthroughs.

The President's budget message is, of course, in our system of governmental balances, not the final word. There is every indication that both houses of Congress will give unusually thorough attention to competing claims for additional financial support in this election year. Whether the budget as it stands is adequate for defense for the immediate future, and more importantly, whether it provides sufficient dynamic force to enable the U. S. to overtake the Russian lead in missile and space techniques before they attain a permanent superiority must be decided by those executive and legislative leaders who have access to all the secret evidence involved. It becomes increasingly important for us all to rededicate our efforts to elect level-headed citizens to these positions of leadership this November.

Without assuming to prejudge these debated issues, we would like to mention the observation recently voiced by Chet Huntley in his NBC news commentary, that many top service commanders, with no personal axes to grind, have expressed their conviction that we are in danger of hopelessly falling behind the Russians in this vital race. We submit that there is no question of either the ability or the patriotism of these commanders, and that their testimony should not be dismissed as inter-service rivalry.

The legislative program of 1960, together with the philosophy of the leaders we elect in November, must ensure that the U. S. will meet the Russian challenge by courageous action.

CORRECTION

Mr. Wilson Greatbatch, author of the article "Instrumentation for Space Medicine Applications," featured in the November-December 1959 issue of MILITARY SYSTEMS DESIGN; has asked us to state that a mention of Space Project MERCURY in the lead paragraph of his article was not intended to imply that the Taber Instrument Corporation is engaged in any part of that project.

The offending phrase had been editorially substituted for the term "space vehicle" in Mr. Greatbatch's original manuscript. When the revised version was approved by the author, the erroneous implication that might be drawn was not detected until the published article was received. Immediately asking us by telephone to disclaim current participation of his company in Project MERCURY, he has since confirmed this request by letter, in which he adds: "I have already received several long distance calls of a very complimentary nature regarding this article making it quite clear that your magazine is read by many highly placed people."

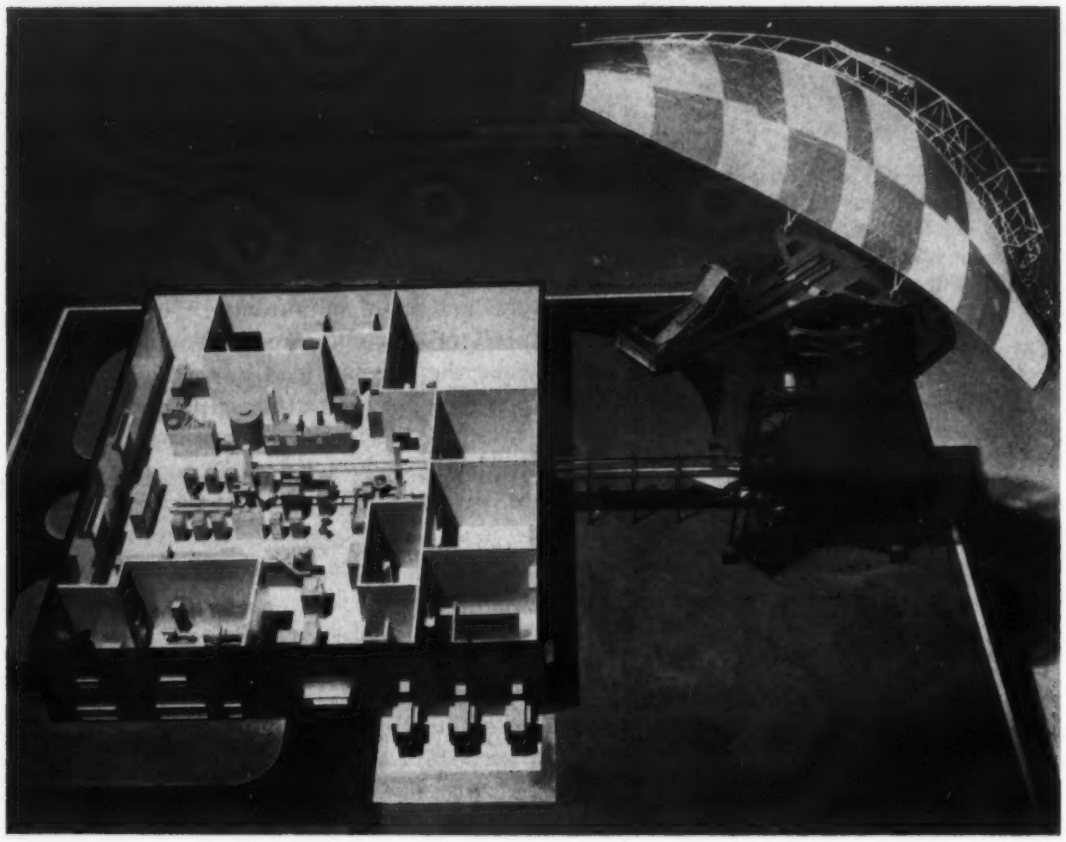

FIG. 1. TYPICAL OF Radar discussed is the AN/FPS-24, designed and developed by the G. E. Heavy Military Electronics Dept., in cooperation with ARDC's Rome Air Development Center, shown in model layout.

THE TRANSMITTING equipment for a missile detection radar system must be capable of furnishing sufficient pulse energy to permit detection of objects possessing very poor reflection characteristics, at ranges in excess of one thousand miles. Such detection capabilities require somewhat different concepts of transmitter operating conditions than are customary for present day aircraft detection radar equipment.

As an example, consider a typical aircraft detection radar transmitter having a peak RF power output of several megawatts, a pulse length of several microseconds and a detection range of somewhat over one hundred miles. For purposes of comparison, assume the pulse length and peak power of this transmitter can be varied at will to extend the range of this equipment to somewhat in excess of one thousand miles. Reference to the radar range equation* will show that the transmitted pulse energy (product of pulse length and peak power) must be increased by a factor of ten thousand (Fig. 3). It thus becomes apparent that one practical method of accomplishing long range detection would be to increase the transmitter peak power to several tens of megawatts and to increase the transmitted pulse length to several thousands of microseconds. Simul-

Missile Detection Radar Transmitter Considerations

C. J. EICHENAUER, JR., Heavy Military Electronics Dept. General Electric Co.

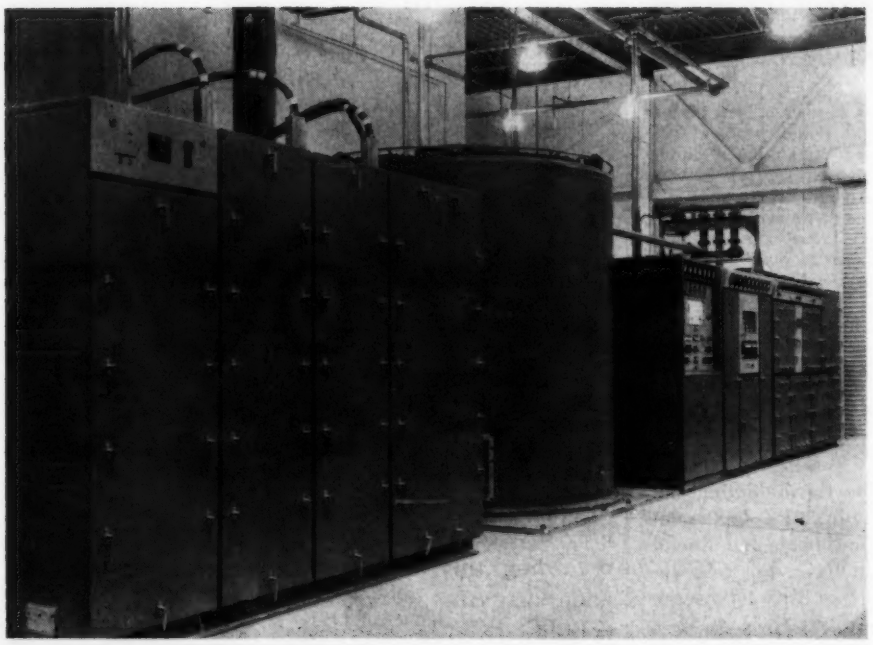

FIG. 2. HIGH POWER Transmitter Units line up (left to right) as: Power Amplifier Modulators, Power Amplifier Tube (Center tank), Power Amplifier Controls, Intermediate Power Amplifier and Driver Units.

*The expression is as follows:

$$R = \sqrt{\frac{P'T'\sigma\lambda^2}{(4\pi)^3\,KT}}$$

Where R = Theoretical free space range of radar
P' = Peak transmitted power in watts
T' = Pulse duration in seconds
σ = Effective target area
λ = Wavelength of transmitted power
$KT = 4.11 \times 10^{-21}$ joules

The formula assumes that R, σ and λ are expressed in the same units, that the receiver adds no noise, and that the received signal is visible on an indicator when signal and noise energies are equal. (From "Reference Data for Radio Engineers," p. 808, Fourth (current) Edition, I. T. & T. Corp., 67 Broad St., New York 4, N. Y.)

THE AUTHOR

Mr. Eichenauer is a design engineer in the Marine and Ordnance Radar Engineering Section of the General Electric Company's Heavy Military Electronics Department, Syracuse, N. Y.

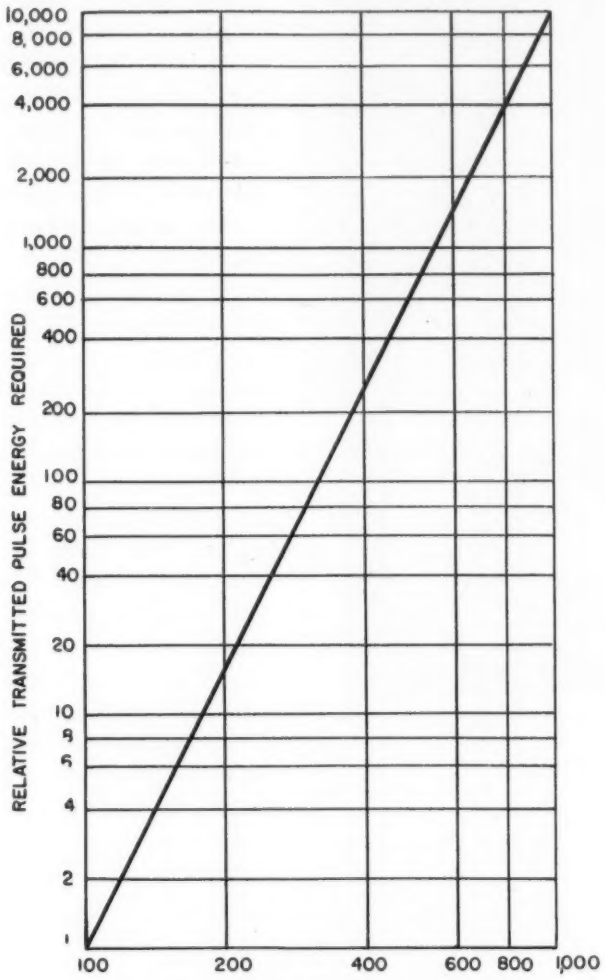

FIG. 3. POWER vs RANGE relationship for detection of a distant object is based on a unit of power required to detect the same target at a range of 100 miles.

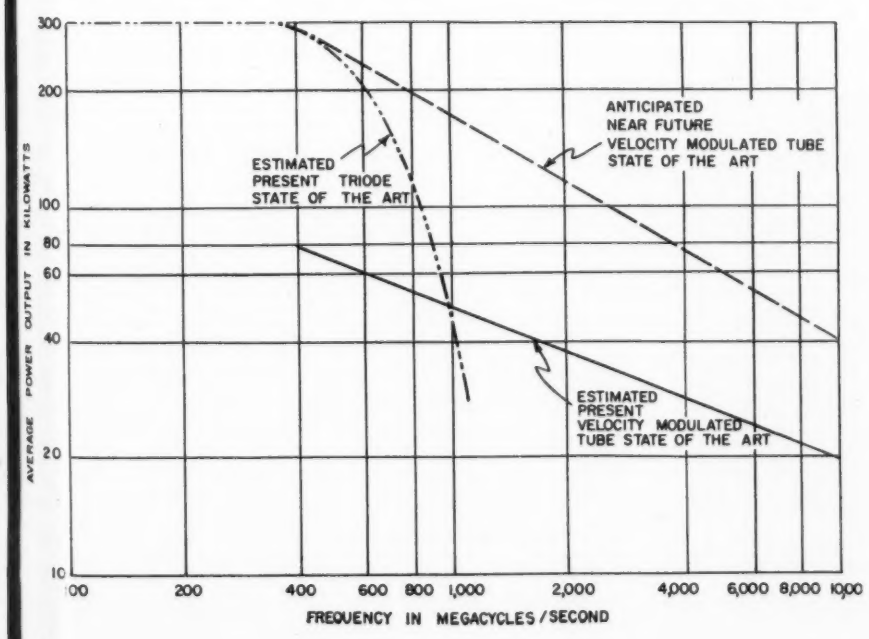

FIG. 4. CURRENT AND PROJECTED Performance Capabilities for High Power Radar Transmitter Tubes.

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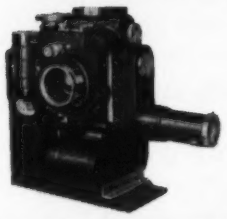

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taneously, if the radar is to have an unambiguous range of at least a thousand miles, the pulse repetition rate must be reduced to less than eighty pulses per second.

Two methods of decreasing the peak power and pulse width requirements of such a radar system would be to: *First*, improve the receiver noise figure and *second*, increase the antenna gain. Both of these approaches have practical limitations. The usual practical result is that the radar transmitter must supply a multimegawatt peak RF power output at a pulse duration in the range of several hundred to several thousand microseconds in duration. Even with the low pulse repetition rates encountered, the transmitter must supply average RF power outputs in the order of hundreds of kilowatts.

Transmitting tubes capable of supplying these levels of power output introduce compromises in the design of the radar system. For instance, the radar operating frequency should be as high as possible to allow the smallest possible antenna beamwidth for a given antenna physical size. Paradoxically, at least in the case of triode and tetrode transmitting tubes, the frequency should be as low as possible to realize the greatest RF power generating capability. Presently the largest available triodes are rated to produce five megawatts of peak power output and three hundred kilowatts average power output, up to a frequency of about four hundred megacycles. Above this frequency the output of presently available triodes falls off rapidly, and other tube types must be considered for the transmitter (see Fig. 4).

Velocity modulated tubes such as klystrons and traveling wave tubes generally take over where triodes leave off in the frequency domain. In the four hundred megacycle region there are currently available klystron amplifier tubes rated at one and one quarter megawatts peak power and seventy-five kilowatts (Fig. 5) of average power. The state of the art appears to be developing rapidly with these klystrons, and tubes having four times these ratings should be available in this frequency region in the near future. Velocity modulated tubes in their simplest form suffer somewhat from the same weakness as triodes, namely that as the desired operating frequency is increased, the maximum power output is decreased. The consensus seems to be that the power outputs obtainable should hold up fairly well through L band, fall off through S band, and decay rapidly through C and X bands.

Cross field tubes such as the magnetron and the amplitron also present possibilities for the transmitter application. In general, the magnetron, a self excited oscillator, does not possess adequate frequency stability for most applications. The amplitron (or similar type cross field amplifiers) will undoubtedly have important applications, but since it is a relatively recent development, less is known about its ultimate possibilities for this type of application.

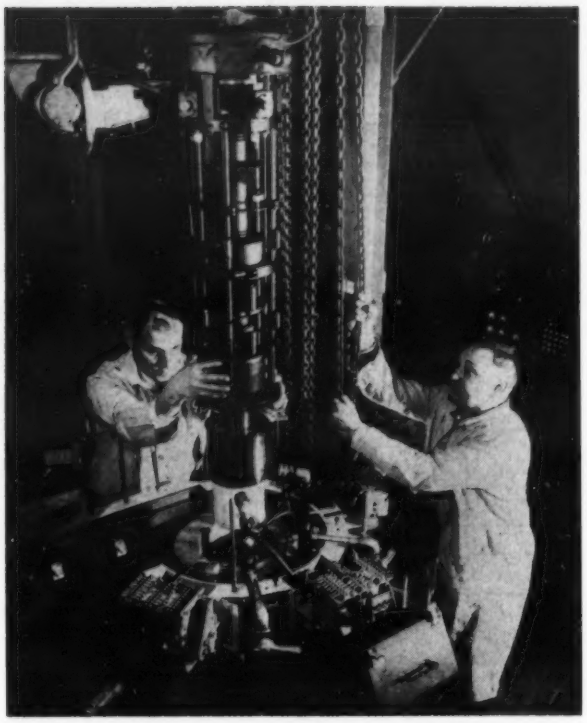


FIG. 5. MULTI-MEGAWATT KLYSTRON being installed in FPS-7 Radar Transmitter.

In any case, the usual missile detection transmitter requires the output of more than one RF amplifier tube to generate the power required for detection. The combining of the output of several tubes may be accomplished either before feeding the antenna, by means of RF waveguide combining techniques, or the combining may be done by multiple feeds at the antenna reflector.

The frequency stability aspects of the missile detection transmitter, especially the short term stability requirement, are usually quite severe. Excellent interpulse and intrapulse stability are required since low frequency doppler information is generally read out on the targets. Crystal controlled oscillator and multiplier chains are the rule. The phase-versus-beam voltage characteristics of velocity modulated tubes places critical requirements on the ripple and droop characteristics of the pulser waveforms. Also some systems employing pulse compression techniques introduce the additional requirement that the velocity modulated power amplifier tubes must have an absolute minimum of departure from the normally linear characteristic of phase delay versus operating frequency.

The pulsers for transmitters of this sort may take at least three forms, the line type pulser, the straight hard tube pulser, and the modulating anode pulser (see Fig. 6).

The line type pulser offers many advantages for long pulse high power operation. It can be shown

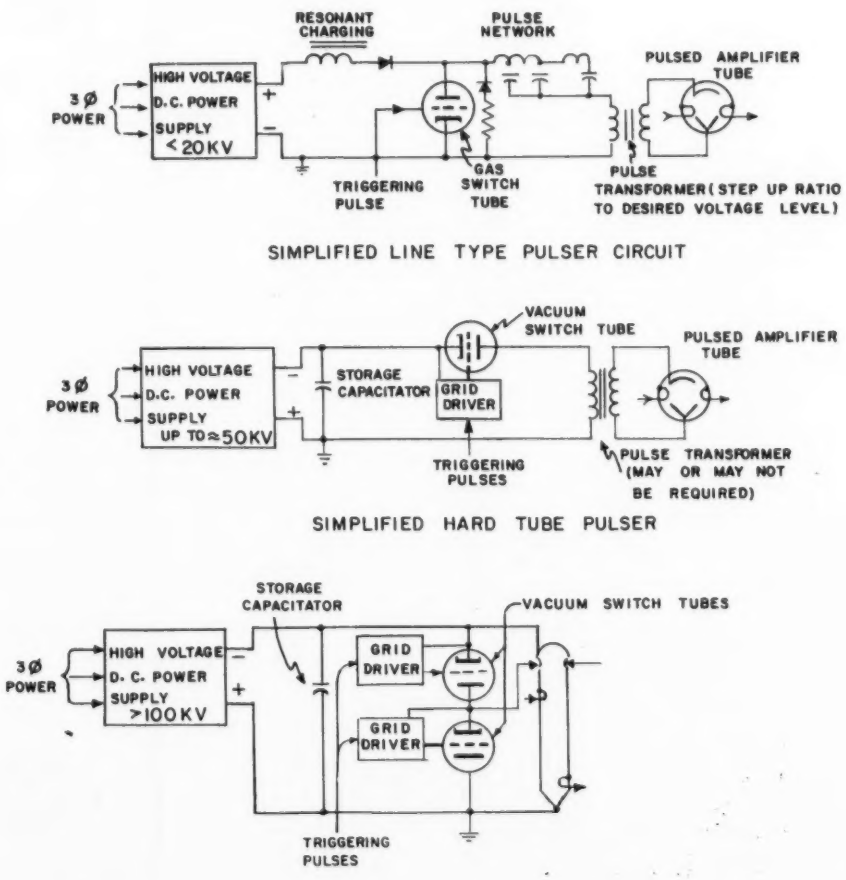


FIG. 6. PULSE MODULATION of Radar may take at least the three forms shown in these simplified diagrams.

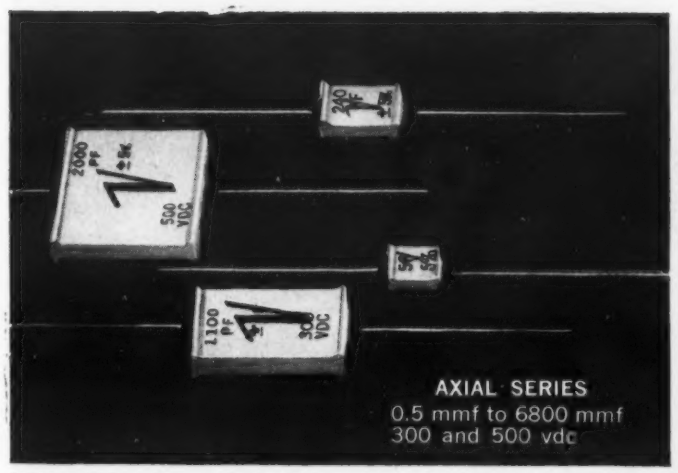
to be the least space and weight consuming (due to the much lower voltages involved in the major components) and the most economical method of obtaining long, high-powered pulses. By careful network design the pulse ripple can be reduced to less than one-half percent peak to peak and the droop at the pulse transformer secondary can be reduced to less than one-half percent. Should lower levels of ripple be necessary, pulse clamping techniques may be employed.

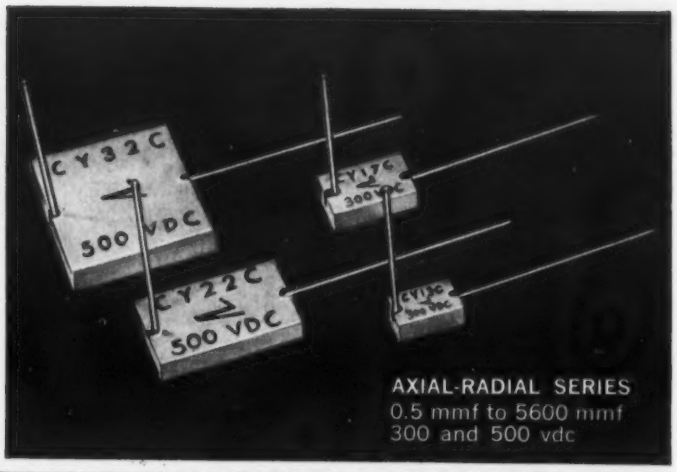
The straight hard tube pulser relies on drawing energy from a capacitor bank during the pulse period and employs large vacuum tubes as a series switch. At voltages within the ratings of existing switch tubes, (usually less than fifty kilovolts) this technique is very practical. Higher pulse voltages may of course be obtained by employing pulse transformers as in the line type pulser. In theory the pulse has no ripple content on its top, but it does possess a power droop characteristic. This droop is a function of the size of the storage capacitor bank. The hard tube pulser, although more sizable and costly than the line type pulser possesses the advantages of: 1) Greater flexibility of pulse duration adjustment since this is a function of the relatively low level grid driver circuit, and 2) the capability of producing closely spaced pulses in groups (for coded operation) due to the more rapid post-pulse recovery time of this type of pulser.

The modulating anode pulser operates on the principle that a modulating anode equipped klystron need only have its modulating anode connected to its cathode to cut off beam current, or conversely the modulating anode need merely be connected to a prescribed voltage level (usually between one half beam voltage to full beam voltage) to produce full beam current. The klystron beam voltage is applied across the tube at all times.

The basic components of high voltage power supply and high voltage storage capacitor perform the same functions as in the case of the straight hard tube pulser. The function of the vacuum switch tubes differ in that they carry very low currents during the flat top portion of the pulse, however, they must be capable of very high surge currents if rapid rise and fall times are to be achieved.

At operating voltages of under about 100 kilovolts the modulating anode pulsing techinque does not, in general, tax the state of the art of existing high voltage components. At voltages much in excess of this level the switch tube state of the art is a limiting factor, and other methods of modulating anode pulsing must usually be considered. To sum up, the basic characteristics of the straight hard tube pulser are retained by this method of pulsing. Increased size, weight and cost will probably result when compared with the alternate pulsing methods, particularly when the operating voltages involved exceed 100 kilovolts.





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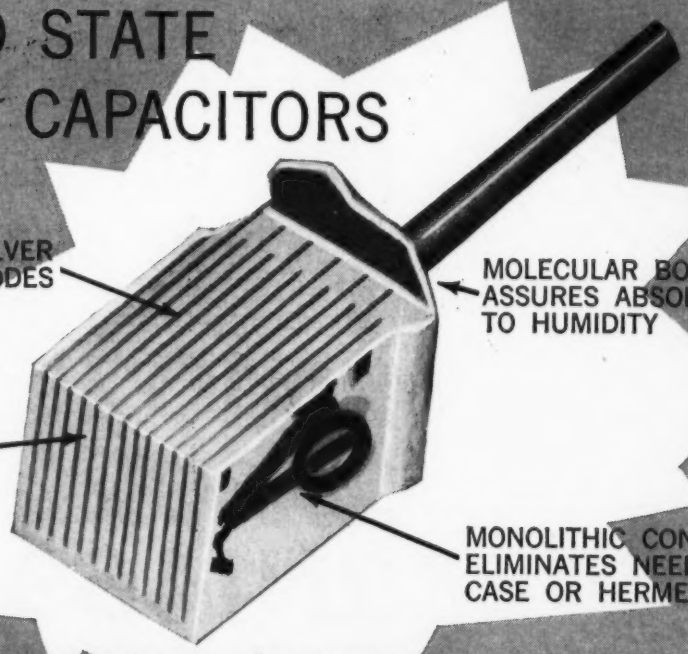
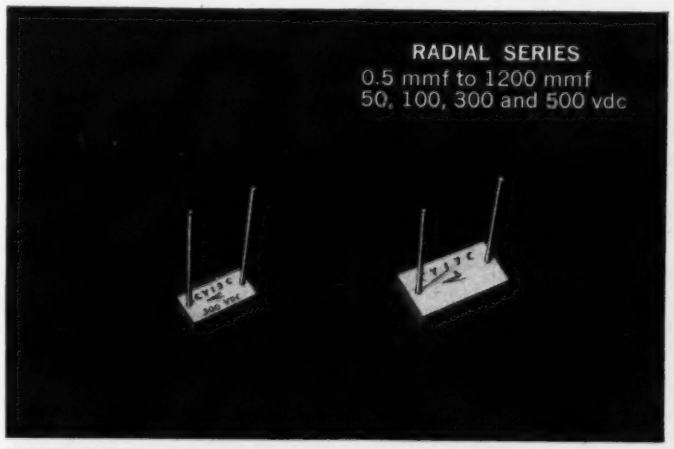


CUTAWAY OF AXIAL CAPACITOR



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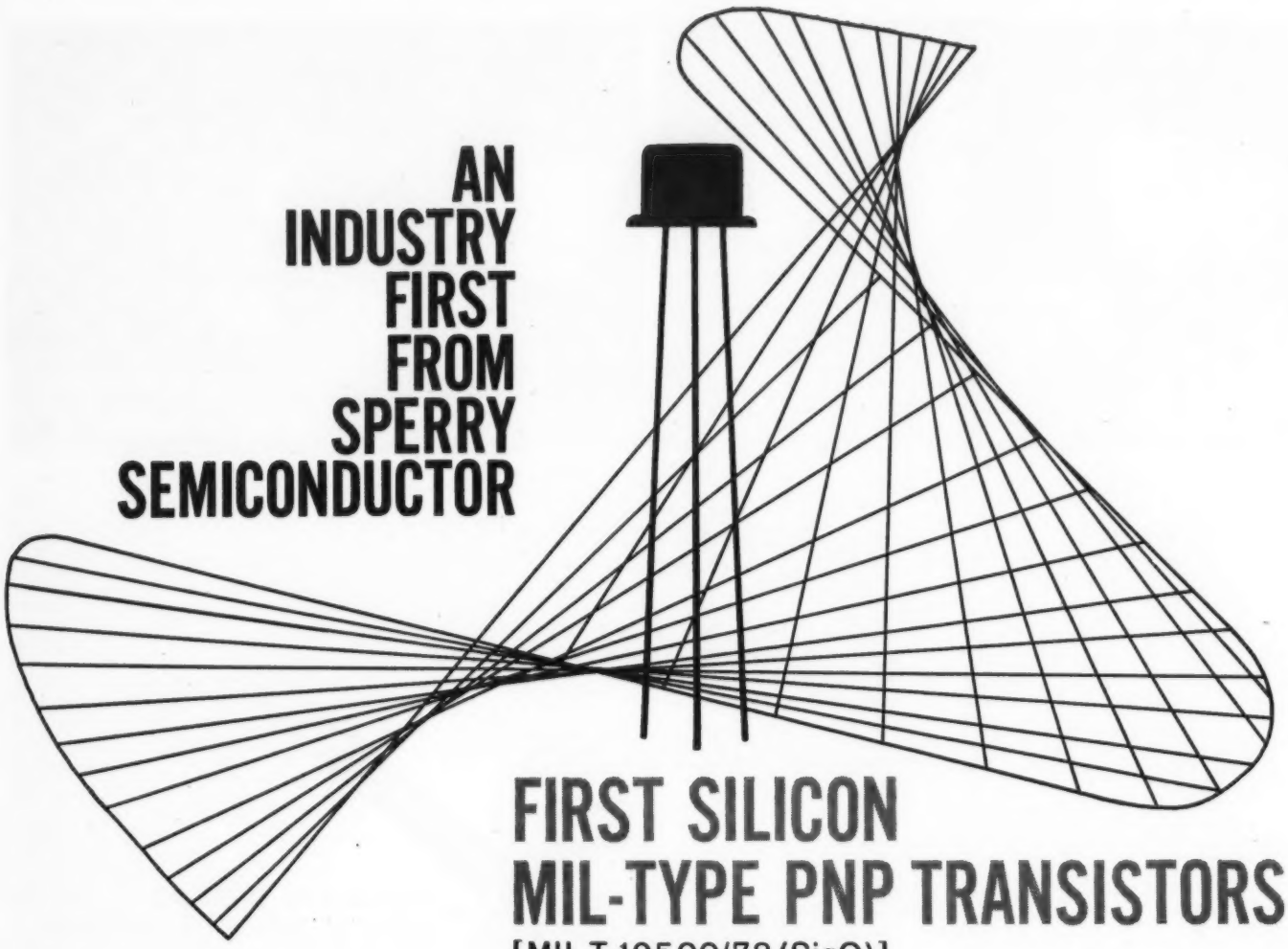

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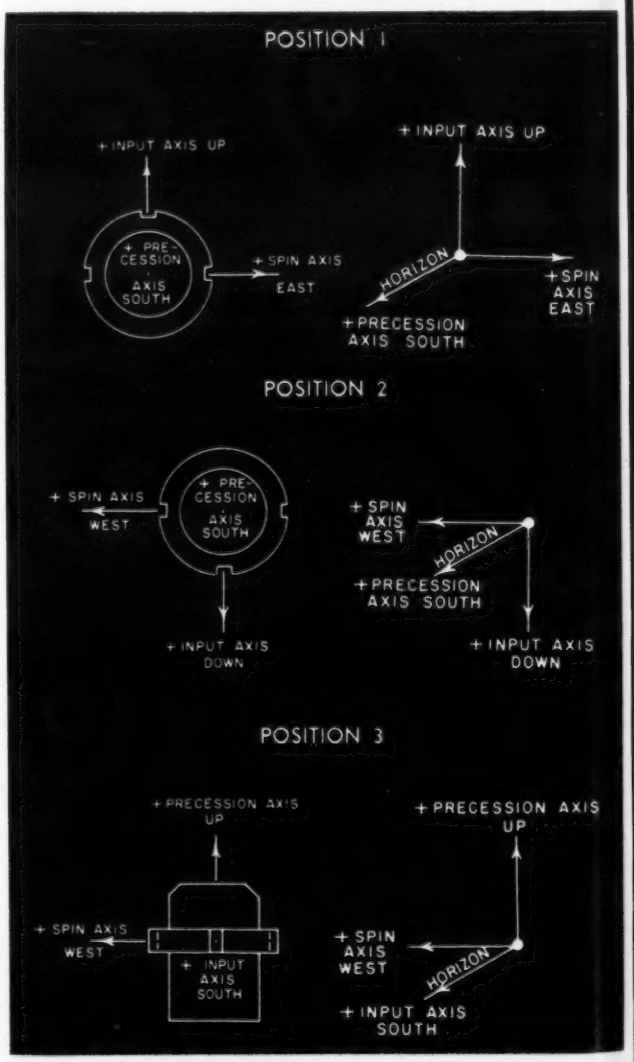
EVALUATION OF FLOATED RA

PERFORMANCE evaluations and test procedures on floated gyros are often conducted differently by one manufacturer as opposed to another; therefore it is useful to know the exact methods by which gyro operating characteristics are established. Applications in which floated rate integrating gyros are used demand precise performance levels throughout the life of these instruments. Consequently, a test and evaluation method must be employed which can faithfully reflect a component's operating characteristics under conditions identical to those which will be encountered in actual use.

Generally, two fundamental methods are used in testing gyro performance, namely, a "closed loop test" and an "open loop test." In the former, the gyro's torquer is slaved to the signal generator and

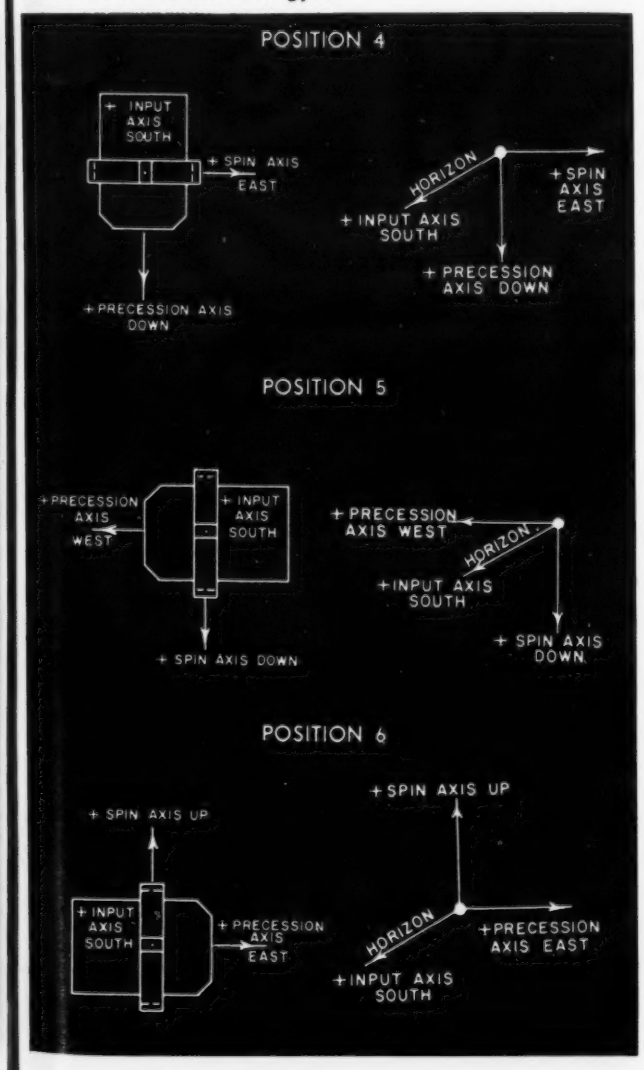
FIG. 1. SIX ORIENTATIONS are each tested 2



RATE GYROS

holds the gimbal at null. Under this condition, gyro performance is reflected by the amount of torquer current required to maintain the gimbal null position. In open loop tests a servoed test is slaved to the gyro signal generator and holds the gimbal at null by rotating the gyro about its input axis. Gyro performance under these conditions is reflected by the table rates required to maintain the gimbal null position. Actual performance of a gyro used in a stable platform is simulated by the latter test method, which is the one employed in Kearfott's six-position test.

Testing a gyro thoroughly in each of six positions has an advantage in that detrimental effects caused by undetected flaws are readily discovered, for gyro failure or poor performance generally become more apparent in some orientations than in others. Hence, tested 25 times for each gyro.



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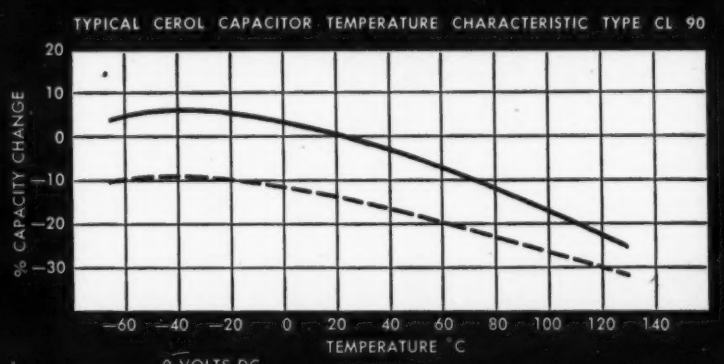
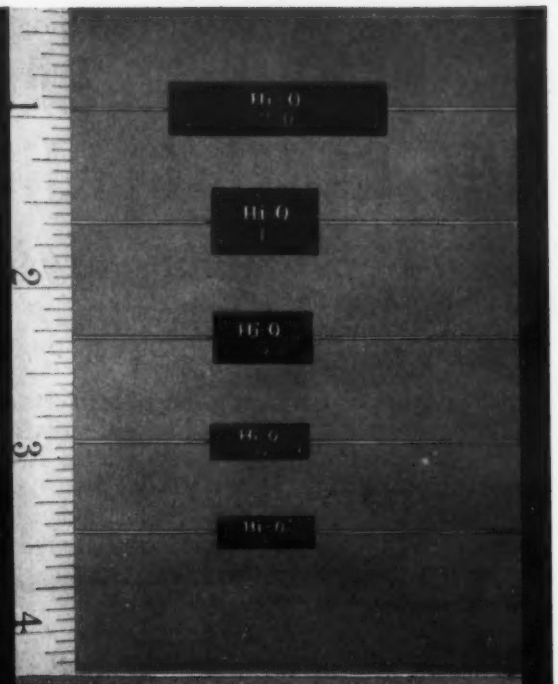


Specifications for Cerol Capacitors, Type CL90

Part Number	Cap. Mfd.	D Max. in.	L Max. in.
CL90V104AM	.1	.210	.690
CL90V254AM	.25	.260	.690
CL90V504AM	.5	.350	.690
CL90V105AM	1.0	.480	.690
CL90V205AM	2.0	.400	1.44

Cap. Tol. = ±20%
P.F. = 2% Max.
T.C. (0 Voltage) = +15% −25% over temperature range of −55° C. to 125° C.
T.C. (100 V. applied) = +15% −35%
Working Voltage = 100 VDC at 85° C. derate to 50 VDC at 125° C.
Test Voltage = 300 VDC
Insulation Resistance = 100 Meg.—Mfd. minimum
Series Resistance < .25 ohms at 8 to 10 mc.
Other requirements per MIL-C-11015B
Leads axial #22 gauge 1½" ±⅛" long



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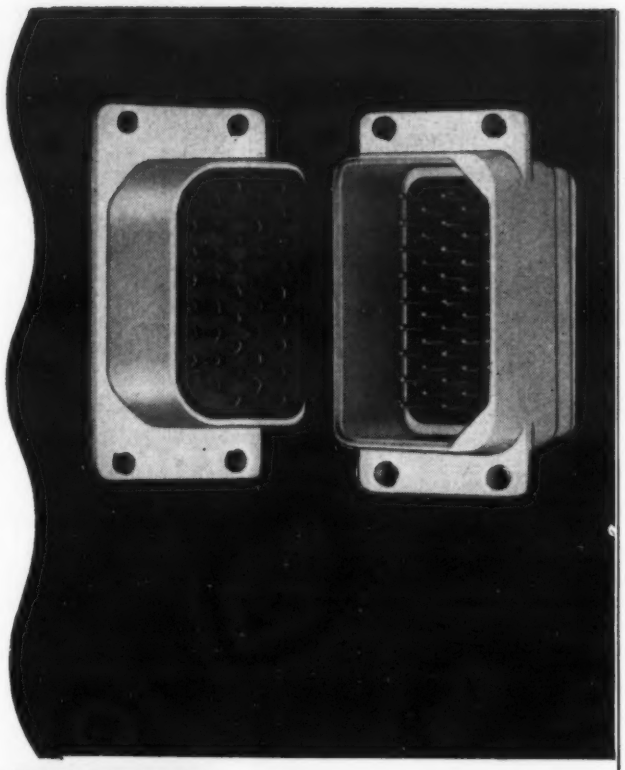

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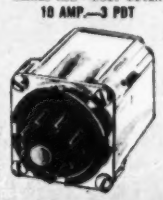
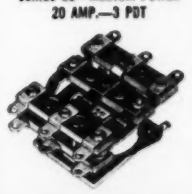


SERIES 26—MEDIUM POWER 20 AMP.—3 PDT



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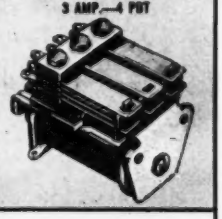
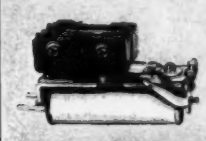


SERIES AS—SNAP ACTION TELEPHONE



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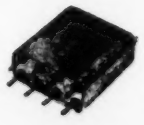

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CIRCLE 9 ON READER-SERVICE CARD

the six-position mode of testing usually exposes any such defects early in the gyro's life.

Six-Position Servo Test Procedure

A servoed test table mounted on a rotary tilt table is a combination which not only simulates actual platform operation but also permits a gyro placed in the servoed table to be oriented in any of six positions desired. As the gyro drifts freely through a precise angle, it is timed. To obtain five consecutive time recordings, the gyro is torqued back to its original position and allowed to drift through the same precise angle five times. This procedure is repeated for each of six orientations (Fig. 1). and each group of six-position tests, is, in turn, repeated five times. Between each series of six-position tests, the gyro is inoperative for the length of time required for cooling.

Mass unbalance along spin and input axes, restraint levels in six positions, and day-to-day repeatability of these parameters are the data obtained. Short term repeatability is also taken at each position.

Six position Servo Test Analysis

The time required for the gyro to drift completely through the precise angle mentioned earlier is termed the "servo table rate" and is a measure of the sum of the torques acting about the gyro's precession axis. These torques, schematically illustrated in Fig. 2, are the result of (1) a component of earth's rate, E_R, along the input axis, (2) a mass unbalance, $M\mu$ of the motor float assembly about the precession axis, and (3) a constant spring restraint, R, about the precession axis.

Formula Derivations

Servo test derivation for positions 1 and 2

POSITIONS 1 and 2

$$\text{Standard Deviation} = \sqrt{\frac{DEV^2}{N-1}}, \text{ where N = number of readings}$$

$$\text{STD. DEV}_1 = \sqrt{\frac{.000132}{4}} = .0058°/\text{hr}$$

$$\text{STD. DEV}_2 = \sqrt{\frac{.001050}{4}} = .0162°/\text{hr}$$

$$\text{Unbalance (spin axis)} = E_R - \left[\frac{|\omega_1| + |\omega_2|}{2}\right] =$$

$$9.843 - \frac{10.300 + 10.710}{2} = -.622°/\text{hr}$$

$$\text{Restraint}_\omega = \frac{|\omega_1| - |\omega_2|}{2} = \frac{10.300 - 10.710}{2} = -.205°/\text{hr}.$$

In the derivations shown above the following is assumed:

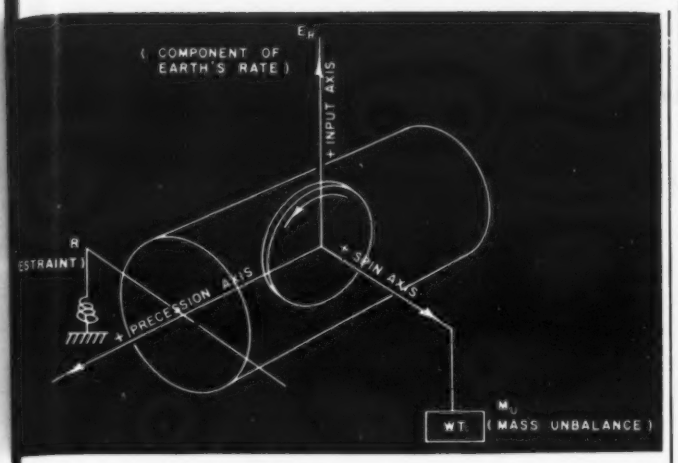

FIG. 2. TIME OF DRIFT is a measure of the sum of the torques acting about the gyro's precession axis.

$9.843°/hr$ = component of earth's rate along a vertical axis, at a latitude of 41.9°N.

$11.372°/hr$ = component of earth's rate along a horizonal north-south axis, at a latitude of 41.9°N.

Earth's rate, E_R, is positive when it causes a positive input to the gyro.

Mass unbalance along the spin reference axis, MU (SRA), is positive when the positive spin reference axis is heavy.

Mass unbalance along the input axis, Mu(IA), is positive when the positive input axis is heavy.

Restraints are positive when acting in a counterclockwise direction about the positive precession axis.

The component of earth's rate along the gyro input axis is greater than the algebraic sum of mass unbalance and restraints.

W_1 = table rate in position; W_2 = table rate in position 2.

Upon completion of the operations described for six-position servo test procedure, the following typical results were obtained for a Model M2516-01A floated rate integrating gyro:

POSITION 1	POSITION 2
$\vec{\omega_1} = E_R - M_{u(SRA)} + R_\omega$	$\vec{\omega_1} = E_R - M_{u(SRA)} + R_\omega$
$\vec{\omega_2} = -E_R + M_{u(SRA)} + R_\omega$	$\vec{\omega_2} = -E_R + M_{u(SRA)} + R_\omega$
$\vec{\omega_1} - \vec{\omega_2} = 2E_R - 2M_{u(SRA)}$	$\vec{\omega_1} + \vec{\omega_2} = 2R_\omega$
$M_{u(SRA)} = E_R - \frac{\vec{\omega_1} - \vec{\omega_2}}{2}$	$R_\omega = \frac{\vec{\omega_1} + \vec{\omega_2}}{2}$
so	so
$M_{u(SRA)} = E_R - \left[\frac{\lvert\omega_1\rvert + \lvert\omega_2\rvert}{2}\right]$	$R_\omega = \frac{\lvert\omega_1\rvert - \lvert\omega_2\rvert}{2}$

(From 8-page brochure, "Alpha Series Miniature Floated Rate Integrating Gyros," Kearfott Div., General Precision, Inc., Little Falls, N. J. in which derivations and typical results for all six positions are given.)

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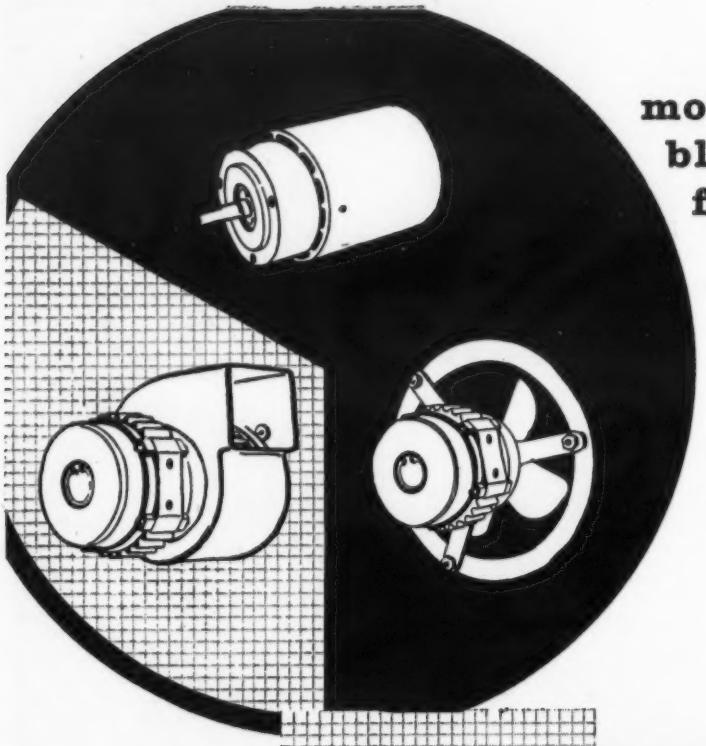

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Synchronous Modulator-Demodulator Component

Synchronization between rectifier contacts at the output and modulator contacts at the input is a requirement frequently met where the circuit input consists of a signal and a reference (Fig. 1). The reference may be ground in a simple dc amplifier or a feedback signal in a servo equipment. Signal and reference are alternatively sampled by one section of the DPDT chopper so that the input to the amplifier is the difference between these two voltages. This difference is modulated to form the characteristic chopper square wave.

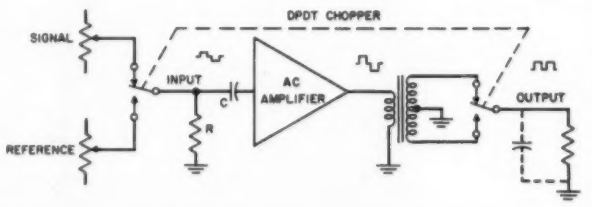


FIG. 1. SYNCHRONISM between rectifier output contacts and modulator input contacts is frequently a requirement in circuits which compare a signal voltage with a reference potential.

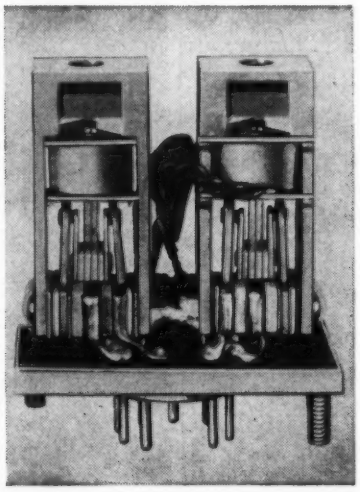
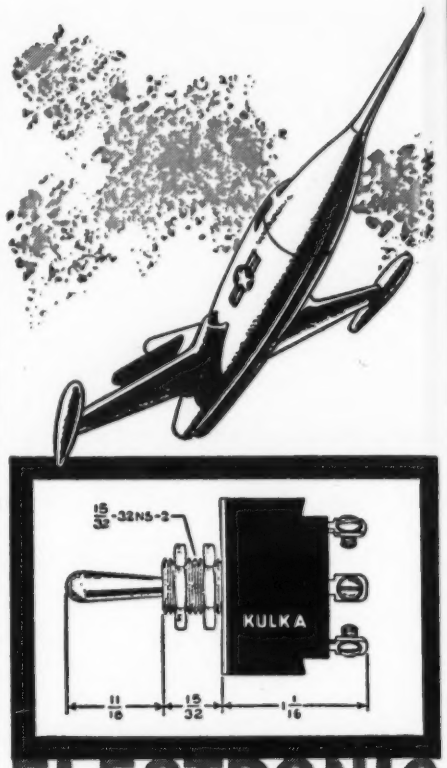


FIG. 2. SPLIT REED construction of Airpax DPDT Chopper fully isolates the two sets of contacts, avoiding troublesome feedback while achieving close tracking.

The sampling action of the chopper—in addition to producing the modulation that enables the dc signal to be amplified in an ac amplifier—prevents interaction of signal and reference circuits on each other, especially when they are greatly different impedance levels, which could be incompatible were an electrical summing resistance network used to obtain the difference voltage.

Coupling capacitor C should have high insulation resistance compared to the resistance of input resistor R to block stray currents in the amplifier input from being modulated by the chopper along with the desired signal. The balanced output of the ac amplifier is synchronously rectified to reconstruct a dc signal. A



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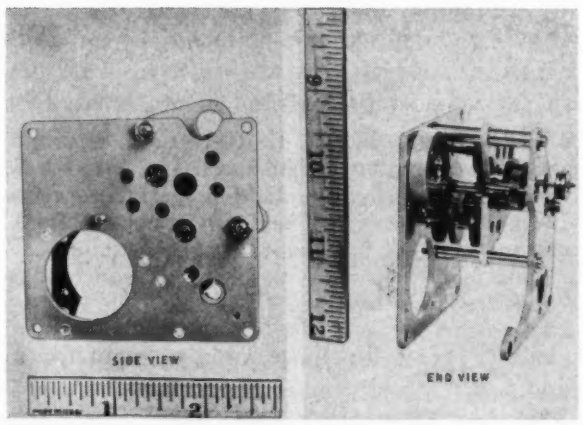
filter capacitor (dotted) can further smooth the output. Because of full-wave rectification, this capacitance can be small. It need be only sufficient to make the output time constant long compared to the off-time of the chopper, whereas, with half-wave demodulation, the time constant is usually made long compared to the half period of the chopper frequency. Thus full-wave demodulation allows the output circuit to respond faster than with half-wave demodulation.

Also, in stabilized dc feedback amplifiers, the split-reed construction of an Airpax DPDT chopper (Fig. 2) fully isolates the two sets of contacts from each other, avoiding troublesome feedback through the chopper. Close tracking of the two SPDT choppers comprising each DPDT unit is assured by adjustments to within approximately 5 electrical degrees during manufacture. Because they are enclosed in the same case, temperature and other environmental changes affect both units alike, thus preserving the close-track relationship.—(*From 2-page technical bulletin C-43 on 60- and 400-cps choppers, Airpax Electronics Inc., Cambridge, Md.*)

FOR THIS LITERATURE CIRCLE 92 ON READER-SERVICE CARD

Rejection Rates Cut

The Pioneer-Central Div., Bendix Aviation Corp., Davenport, Iowa, has reported one instance of annual savings totalling $38,000 from the use of Sonic Energy cleaning in the production of precision gear assemblies with micro bearings (see Figure).



CLEANING OF MICRO BEARINGS was critical task with high rejection rate; now economically and efficiently done by sonic energy method.

Previously cleaned by hand brushing and dipping in a 100% chlorinated solution, cleaning of the assemblies shown is now accomplished in a Bendix Sonic Energy Cleaning System using a solution of Bendix 25-I (water detergent) and ammonium hydroxide at a temperature of 140°—160°F. Rejects due to contamination which previously amounted to 56% have been entirely eliminated with a savings of $28,000 and the cost of two inspectors also eliminated at annual savings of approximately $10,000. The cost of the cleaning system was amortized in only four months.

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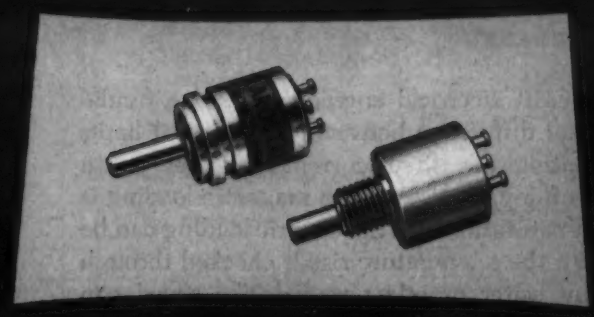

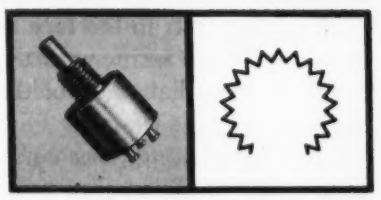

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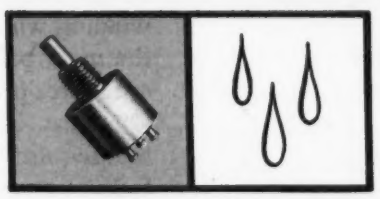

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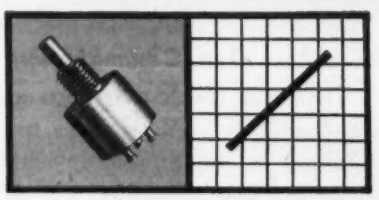

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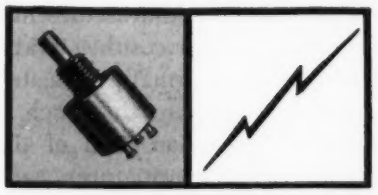

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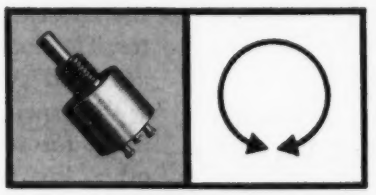

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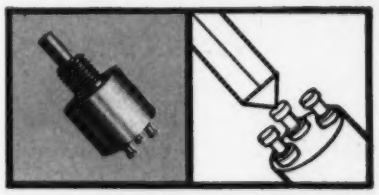

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THE DOUBLE ARMATURE MOTOR-- A SPECIALIZED TYPE OF D. C. MACHINE

ANDREW BEKEY, Bekey Custom Motors Div., Genisco, Inc.

PIONEER electrical engineers found a fundamental difference between the physical limits for alternating and direct current machines. In an ac motor of any given size, the magnetic loading is limited by saturation, but the electric loading can be increased if the temperature rise is checked through cooling by water or other media. The speed can be increased to the maximum values of safe hoop-stress on the rotor. For these reasons, the size of ac machines can be built without physical limit to megawatt sizes or in extremely fast, small, water-cooled units.

The Commutation Problem

However, for dc machines commutation is a major limiting factor. Very large units, e.g., 100,000 kw, 3,600 rpm, are impossible with direct current commutating machines. From basic motor theory it can be demonstrated that for any dc motor with armature diameter D; armature conductor current Ia; and having a number of armature conductors Z_s in series; the armature loading Q can be expressed by the equation

$$Q = \frac{I_a Z_s}{\pi D}, \text{ or } \pi DQ = I_a Z_s \qquad (1)$$

Also, if a field flux sufficient to induce an average emf of e volts per conductor be assumed, the total power

$$P = \pi DQe = I_a Z_s e = Ia\ E, \qquad (2)$$

where $E = Z_s e$.

From this, $$D = I_a E/\pi Qe = P/\pi Qe \qquad (3)$$

Although the speed of rotation does not enter this equation, e is limited by commutation and Q by saturation. If these limiting values are inserted in equation (3) we obtain the maximum possible power for a given armature diameter or conversely, the minimum possible diameter for any given output.

In contrast to ac machines, the output for a given diameter D connot be increased by higher speed, because e, the induced voltage, would rise. To limit the maximum voltage between commutator bars, the number of segments would have to be increased. For a given output current, this requires a larger commutator, resulting in higher brush speed or shorter time to reverse the current in the coil being commutated.

To minimize commutation difficulties, a standard method is to equip a motor with commutating poles. In Fig. 1 the current flowing in the armature will set up a magnetic field ϕ_q due to armature reaction. When this combines with the main field flux ϕ_1, the main field is distorted. Although this distortion may be met by shifting of the brushes, magnetic compensation is generally used. A compensating winding which can be placed in slots in the face of the main poles, when connected in series with the armature, provides magnetic cancellation ϕ_c of the armature reaction flux. It is evident that this solution requires a number of compensating turns equal to the armature turns, thereby doubling the resistance of the armature path without adding to the torque produced.

The Double Armature Solution

In the quest after increased dc machine output, the latest development is the double armature motor. The double armature motor replaces the stationary field system with a second armature located with respect to the first armature so that each is using for its main field the reaction field of the other. Fig. 2 shows two concentric armatures, each having the same number of armature conductors, and with stationary brushes 90° from each other. Here the reaction field of armature 1 (ϕ_{q1}) is in the correct position to serve as the main field for armature 2, and vice versa.

In the first approximation this double armature device has a number of advantages, evident from an inspection of equation 3:

1. The number of active conductors IaZa is double.

2. The volts induced per conductor being the same, the use of two commutators in series gives twice the voltage per machine.

3. If over-all voltage is the same as for single commutator machine, voltage between commutator bars is half as great for the double commutator machine.

However, because the field structures are eliminated, the interpoles are missing and commutation requires new considerations. Furthermore not all conductors are active at all times.

Several double armature motors were built with axial airgaps and some with radial airgaps. In the latter case the two armatures are concentric, and may assume various configurations, two of which are shown in Fig. 3. In Fig. 3_a the brushes ride on the periphery of both commutators. In Fig. 3_b both sets of brushes bear on the inner surfaces of the commutators.

One result of the mutual sharing of the airgap by two reaction fields is that in some conductors the emf's and torques will cancel out, leaving only the conductors lying in the regions of maximum flux

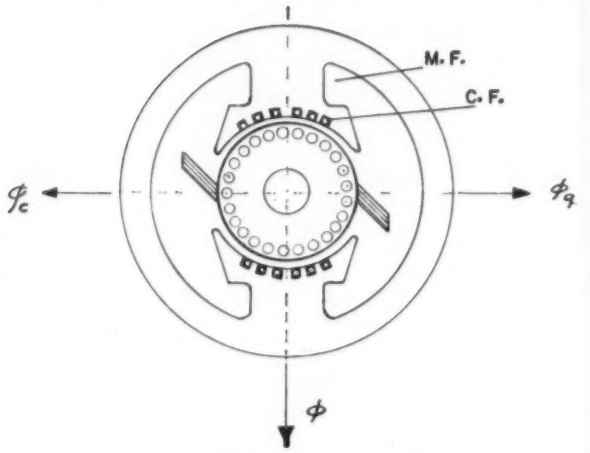

FIG. 1. CONVENTIONAL DC MOTOR relies on interpoles or compensating windings to counteract magnetic field shift caused by armature reaction. Opposing magnetic fields limit capacity in dc motor design.

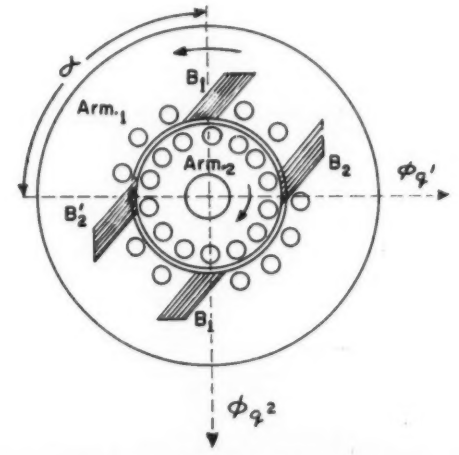

FIG. 2. EACH COUNTER-ROTATING armature in novel two-armature motor produces a reaction field which serves as the main field of the other armature. Armature$_1$ rotating in field ϕq_2 is commutated by brush pair $B_1B'_1$ to produce reaction field ϕq_1. This is the main field for armature$_2$, which in turn produces reaction field ϕq_2.

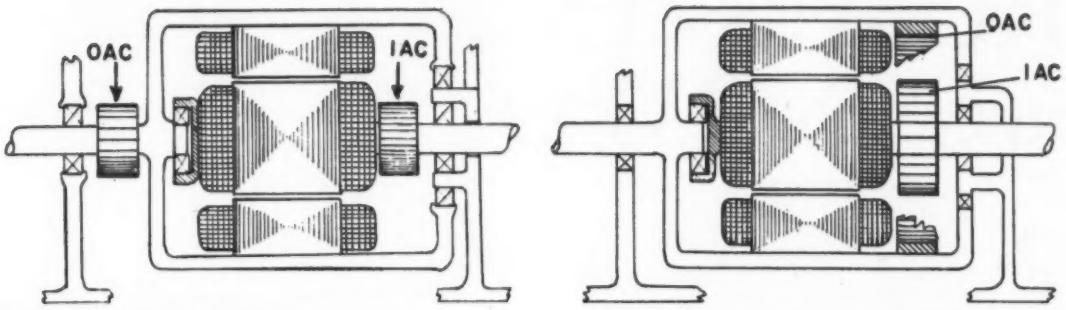

FIG. 3. TWO CONFIGURATIONS of double armature motors. Inner armature (IAC) and outer armature (OAC) commutators are labeled. Angle between stationary brushes (not shown) may be adjusted for optimum operation.

density to contribute to the net torque and emf. If these are called "active conductors" the relations between brush angle to percent active conductors, percent peak flux density and net torque per ampere can be expressed by the curves in Fig. 4 based on investigations by Schauer. The influence of saturation is also shown.

From these curves we seen that in an unsaturated motor with 90° brush angle only 50% of the conductors are active and, even if there are twice as many conductors carrying the same current, the net number of active conductors is the same as in a single armature motor. Therefore, the torque, and consequently the power output, is not increased at this brush angle.

If the effect of saturation is considered, the comparison with a conventional single armature motor becomes more favorable. The optimum brush angle increases to between 120 and 150 electrical degrees and the fraction of active conductors to the 67% to 83% range. This represents an increase of from 33% to 60% over the net ampere-conductors in a conventional motor of the same size.

Double Armature Communication

In order to appreciate the problem of commutation in a double armature motor, we must first assume that the machine is not saturated. The conditions are similar to those in a conventional single armature motor; however, regardless of the brush angle, the coil being commutated is always located at the trailing edge of the region of maximum flux density. This means that the coil has a voltage induced in it, but its direction is in opposition to the coil current and tends to aid commutation by helping to reverse the current. For successful commutation this emf must be of proper magnitude, i.e., equal and opposite to the emf of self and mutual induction (also called reactance voltage) which tends to retard commutation.

Instead of the interpoles or commutating windings used in conventional machines, it is preferable to use the length of airgap L, to establish a balance between induced and reactance voltage. For an unsaturated machine, it can be shown that by proper choice of the air-gap, this balance can be held independent of armature current:

$$L = 0.2\frac{D}{P}\left(2 - \frac{\alpha}{90}\right) \qquad (4)$$

where L = length of airgap
D = diameter of armature
P = number of poles
α = brush angle in electrical degrees

For best commutation in an actual machine, an airgap length somewhat less than the computed amount is used to compensate for the reluctance of the magnetic circuit.

For commutation under varying loads an adjustable airgap is recommended. This can be achieved

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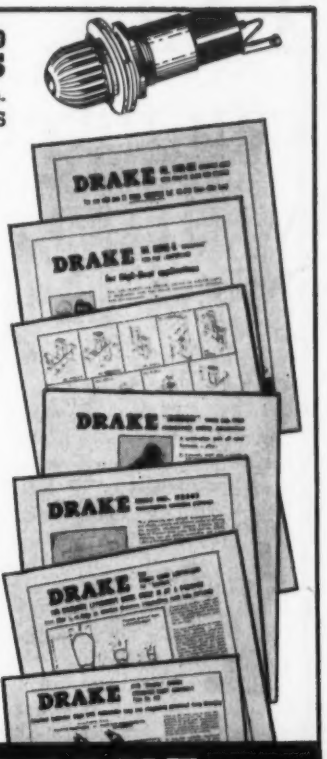

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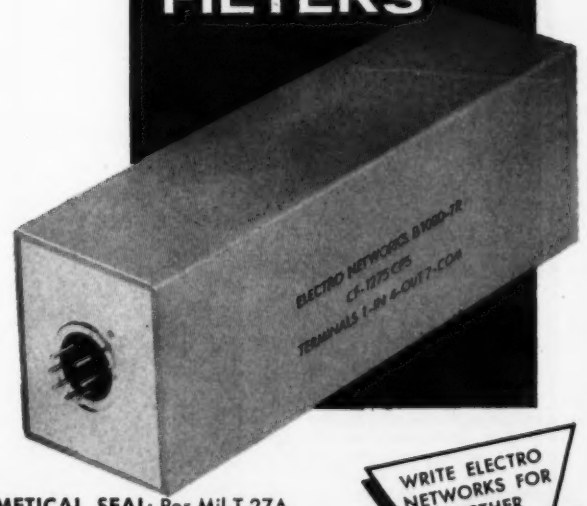

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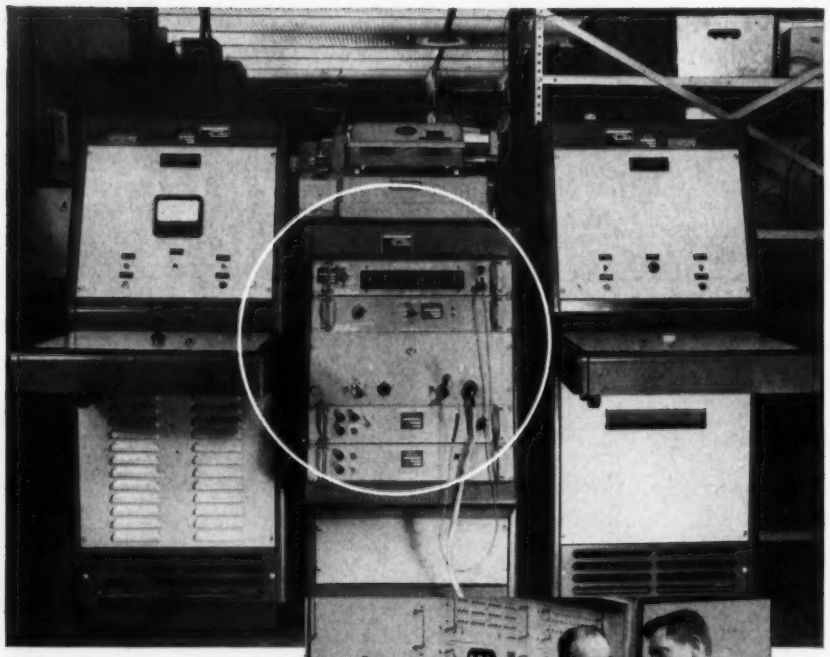

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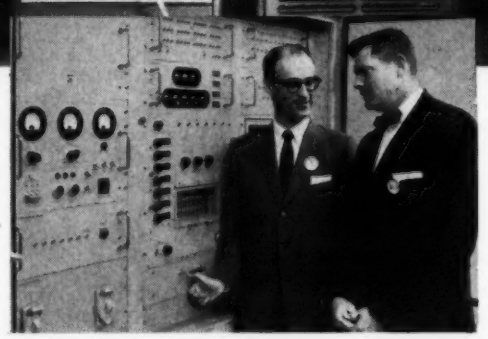

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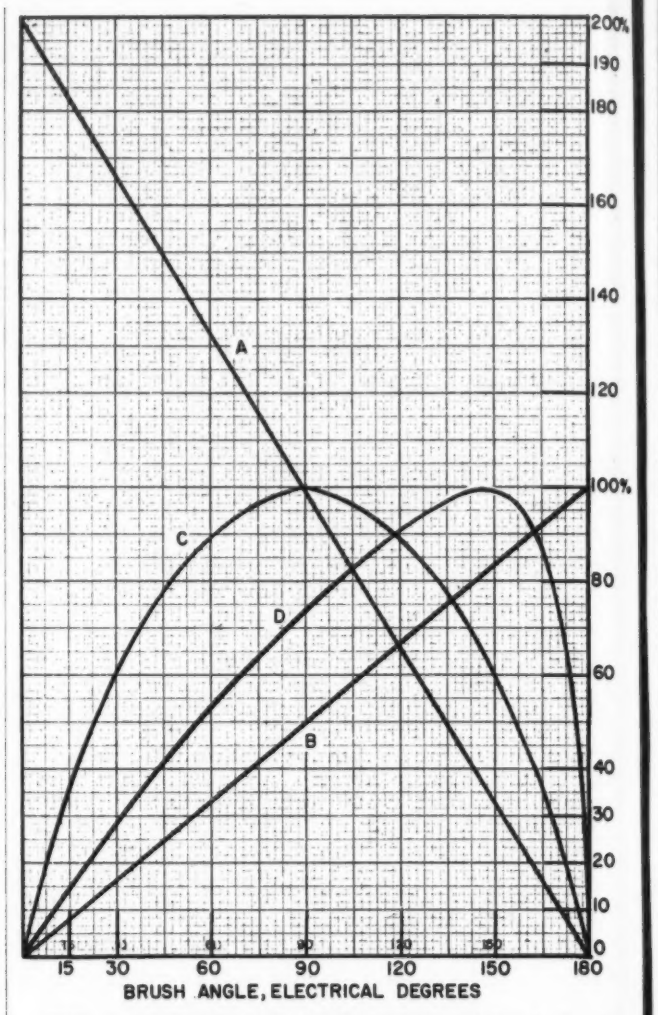

FIG. 4. DOUBLE ARMATURE MOTOR Brush Angle settings vs other characteristics of motor: Vertical Scales are (A) peak magnitude of combined mmf in % of peak mmf for one armature; (B) % active conductors; (C) Torque/ampere for unsaturated motor in % of maximum; (D) Torque/ampere for highly saturated motor in % of maximum.

by axial airgap machine or by conical surface radial gap machines. For a fixed airgap best commutation is possible only at a particular load. Smaller loads produce over-commutation, larger loads under-commutation. Some adjustment is possible by changing brush angle α but only at the cost of lower than optimum performance.

Applications

The double armature motor here described is not the end product of a development but only the first experimental model, first applied to drive an under water device through counterrotating propellors (Fig. 5). Even so, it developed 27.7 hp, having a weight of 55.5 lbs. It also is interesting to note that while the relative speed of the armatures is 4,200 rpm, each propellor rotates only at 2,100 rpm.

In this motor, both sets of brushes were riding on internal commutators with the inside armature using heavy rectangular conductors potted in epoxy resin and with the coil extension machined to a commutator. Both parallel and series connections were

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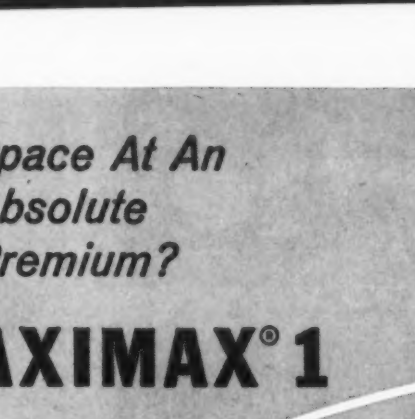

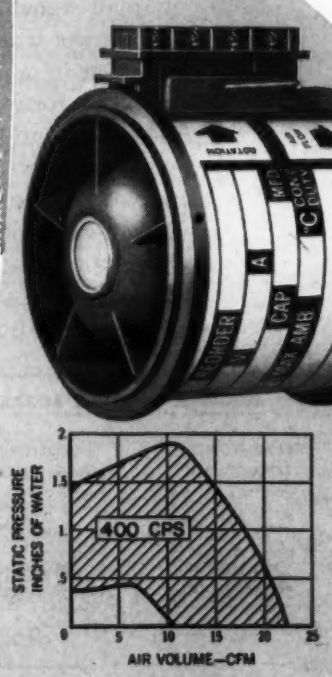

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tried, and the brush angle could be adjusted from 90° to 150°.

Operating characteristics are different for series and parallel connection of the armatures.

In parallel connection, terminal voltages on both armatures are constant. If speed-torque current characteristics of both armatures are all equal and both loads identical, both armatures will develop equal torques and draw equal current. However, if the load characteristics are different, the armatures draw different currents, develop different back emf's and produce different reaction fields. Consequently the two armatures will run in different strength fields, and at different speeds. Under these conditions the composite field is no longer symmetrical, and the distortion will affect efficiency and

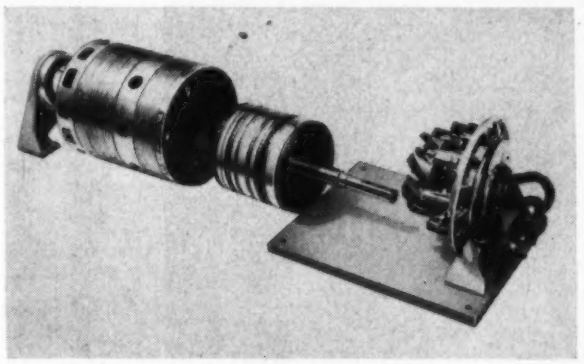

FIG. 5. DOUBLE ARMATURE MOTOR for driviing counterrotating propellers of underwater device developed 1/2 hp for each lb of motor weight.

commutation. If either armature is unloaded but the other armature is full loaded, the loaded armature will lack a proper field and will therefore draw excessive current and burn up. For this reason care must be exercised against losing the load of either armature when they are connected in parallel.

When the armatures are connected in series, if both (or either) armatures are unloaded, the unloaded members will build up to destructive speeds. However, with slightly differing loads the torques and speeds will adjust and with it the division of voltage across the two armatures. However, since the currents are the same the field is not distorted, and commutation and efficiency are not seriously impaired.

It appears that in terms of increased output per volume, the double armature motor may have about a 50% advantage over a conventional motor. Although it appears to be limited to counterrotating applications, for these it unquestionably has superior characteristics to a conventional type motor. To the best knowledge of its developers, The Bekey Custom Motors Div., Genisco, Inc., Los Angeles 64, Calif., no double armature motors are now in production. However, it can be stated that the counterrotating double armature motor is a proven device, which can be designed and built to specifications.

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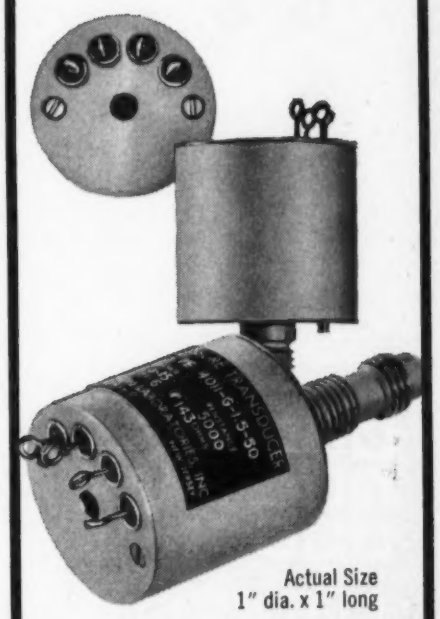

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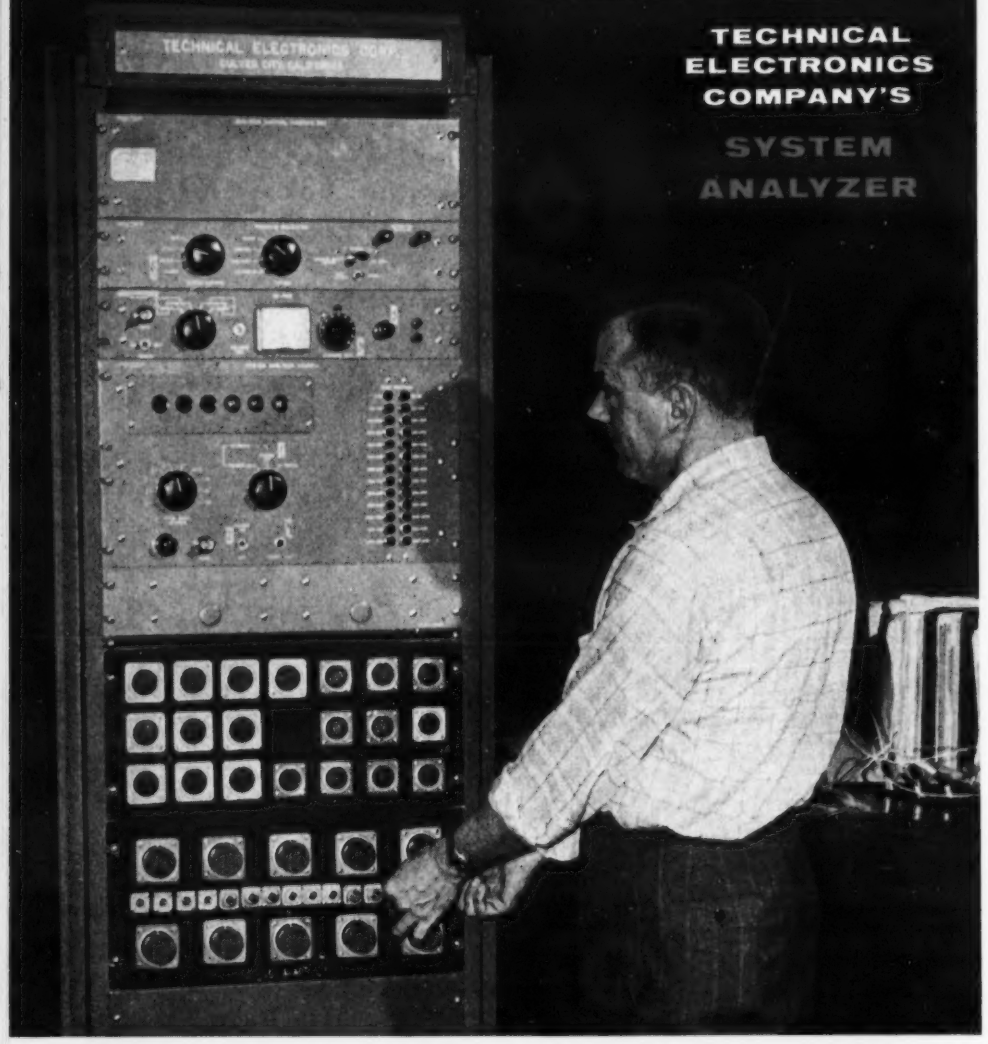

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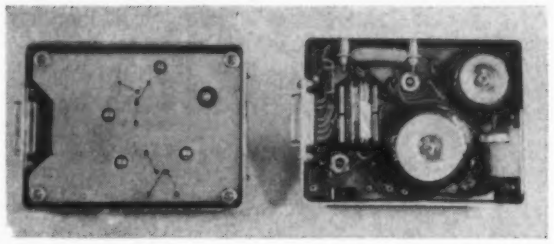

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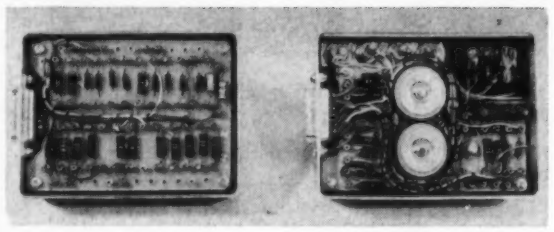

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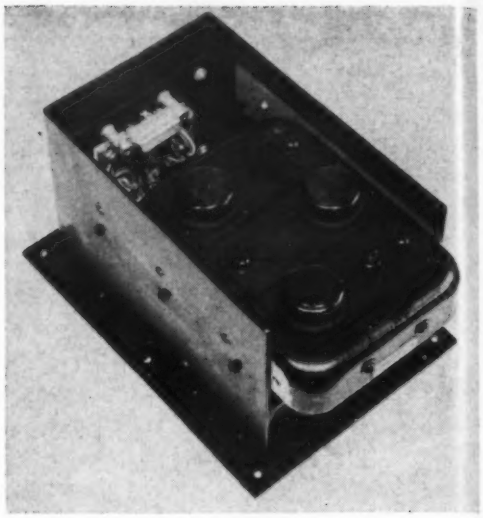

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Working forward from these common factors, Airborne recently developed modular or unitized control amplifiers for control systems. Magnetic and transistorized power amplifiers are now built to operate many motors, produced by Airborne and other manufacturers from the lowest power upwards. For basic low-level gain segments, preamplifiers are also produced in magnetic and tran-

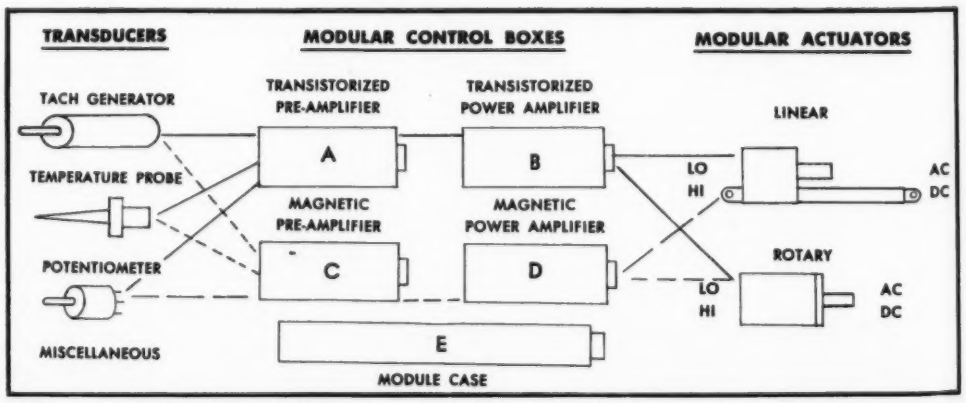

FIG. 1. MODULAR CONTROL, using either transistorized (solid line) or magnetic (dotted line) components housed in standardized cases, accepts sensing signals from a wide range of transducers and drives either high- or low-power actuators. Typical Airborne Accessory modular units are identified at the top of the page by key letters.

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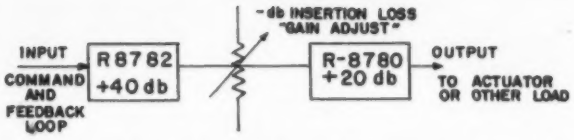

FIG. 2. GAIN VARIATIONS for different applications are met by standardized modules through attenuation in control box programming.

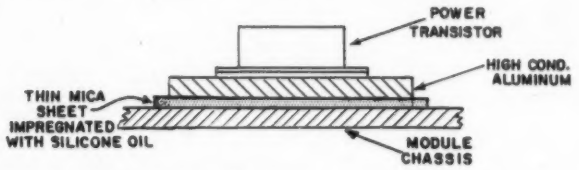

FIG. 3. HIGH EFFICIENCY in heat dissipation is engineered into construction of transistorized Power Modules.

TABLE I. STANDARD AMPLIFIER MODULE CHARACTERISTICS.

	Module	Chassis Operating Temperature	Weight	Input For Full Output	Output Linear Region	Gain	Input Impedance	Load Impedance	Power Output	Excitation Required	3 Db. Frequency Response	"H" Maximum
	Transistorized Pre-Amplifier R-8782	71° C 120° C*	0.64 lb.	400∿ Carrier One Input 25 MV RMS Two Inputs 40 MV RMS Three Inputs 50 MV RMS	5 V RMS 400∿ 60∿ *	One Input 200 V/V Two Inputs. 125 V/V Three Inputs 100 V/V	50,000 Ω Per Channel	500 Ω Nominal	Approx. 50 MW	28 V DC .025 A Approx.	Limited Only By 400∿ Carrier	1.3"
	Magnetic Pre-Amplifier R-8786	125° C	0.8 lb.	20 MV DC	4 V DC Average 3 V DC Average	200 V/V	2K Ω	2000 Ω Nominal 500 Ω	8 MW 18 MW	115 V 400 CPS 5 W	40 Rad./Sec.	1.5"
E-6412 Type Meter or Equivalent	Transistorized Power Amplifier R-8780	71° C 120° C*	1.15 lbs.	400∿ Carrier 60∿ * 3 V RMS	400∿ 35 V RMS Approx.	11 V/V	500 Ω Approx.	Depends Upon Application 50 Ω Center-Tapped Nominal	25 W Continuous 50 W Peak For Lower Load Resistance	28 V DC 0.2 A At Hull 1.5 A At Drive	Limited Only By 400∿ Carrier	1.6"
E-6011 Type Meter or Equivalent	Magnetic Power Amplifier R-8784	125° C	1.15 lbs.	4 V DC	26 V DC	6.5 V/V	2K Ω	25Ω Nominal	27 W DC	115 V 400 CPS 40 W	20 Rad./Sec.	1.8"

*Special temperature and frequency arrangements are available on special order. All modules are 3" wide, 4" long, with height as shown.

Design

sistorized versions. Such standardized gain packages, properly cascaded, provide numerous combinations of control amplifiers suitable for positioning or follow-up servos (Fig. 1).

Each amplifier is packaged in a compact 3" x 4" chassis. These are quickly plugged in a standard control box 5" x 3" x 4" within seconds. When a proper combination is selected and the two units are programmed within the control box, the resulting package is ready to perform many control functions which formerly required custom design.

A number of Airborne's packaged control systems are assembled from off-the-shelf standard units, incorporating modular actuators, linear or rotary, in which design flexibility is achieved through interchangeability of parts. Thus, on this equipment the need for "specials" is eliminated.

Also available from stock are transducers including potentiometers, tach generators, and temperature probes, which sense variations in temperature or other variables to control the electromechanical actuators through the amplifiers. Auxiliary equipment such as rectifiers, inverters, and voltage regulators are supplied as needed.

Outstanding advantages of the modular control system are: Substantial savings in design time, lead time, and overall costs; short delivery time on actual equipment; easier field maintenance, and greater system adaptability. For many applications, engineers can design directly from the matched systems.

Magnetic vs Transistorized Amplifiers

Airborne conducted a comparative study of magnetic and transistorized equipment by specifying as design criteria the same basic transfer functions for the magnetic pre-amplifier and the transistorized pre-amplifier. The same was done with the magnetic and transistorized power amplifiers.

The study revealed that to attain a given power output, approximately equivalent weight penalties were incurred by both types. As first designed, the transistorized equipment appeared to weigh less. However, the additional heat-sinking required in order to attain dissipation ratings soon counterbalanced this weight advantage. Both power amplifiers, capable of obtaining 25 watts output, weighed exactly the same as shown in Table 1.

As expected, the transistorized pre-amplifier proved lighter than the magnetic. At high temperatures the magnetic amplifiers showed a definite advantage in stability per unit cost for the amplification of dc signals. It is possible to make stable dc amplifiers using transistors with good feedback and chopper design, but the cost is prohibitive.

For high power (100 watts output or more), controlled rectifiers lead in the present state of the art. The high efficiency of these units permits high power output per unit weight ratio; but they operate best in the form of a hybrid configuration with magnetic amplifiers driving the controlled rectifiers in thin time-displaced pulses.

The control equipment designer will generally determine the steady-state and derivative loop gains required for a system. Motor performance and gear ratio to the output ram or shaft and the command transducer gain leave few variables in the loop gain; many of these variables are established by the amplifiers.

For reasonably stiff loop gain performance, the amplifier is designed to provide between 10 and 60 DB of amplification. This is done by selecting a representative pre-amplifier and coupling to it the matching power amplifier to drive the load. For convenience, Airborne is presently providing two units of pre-amplification, each with a gain of approximately 200 volts output per volt input and two units of power amplification, each with an approximate gain of 10 volts per volt. The cascaded combination delivers a gain in excess of 60 db which can be attenuated to any desired value (Fig. 2).

Amplifiers are packaged to provide reasonable size and weight, adequate heat dissipation, and MIL-spec-type rugged construction. The amplifier sub-assemblies are designed to be received by the main chassis and properly transmit generated heat to the walls, then down to a conductive heat sink. With the transistorized power amplifier, compact heat design allows further reduction in the relatively large heat gradient at the base of the transistor. This occurs by spreading the transistor's heat output over a larger plate and then allowing the total heat to transfer over a much smaller heat gradient created by the increased area between the transistor mount and the chassis itself (Fig. 3).

Airborne anticipates that standardization of basic gain packages will substantially reduce design repetition and consequent waste of engineering manpower. Customers will benefit from shorter delivery time and lower costs. With fewer aircraft of any one type being produced today—and those becoming obsolete at an accelerated pace—modular unit design is best adapted to meet the quickly changing control requirements of the aircraft and missile industries.

FOR MORE INFORMATION CIRCLE 95 ON READER-SERVICE-CARD

Semiconductor Microwave Power Sources

M. M. FORTINI & J. VILMS, Research Div., Philco Corp.

IN THE EVOLUTION of semiconductors, one of the goals of the device-maker has been to provide the circuit designer with devices capable of generating useful power at ever-increasing frequencies. The direct approach to this problem has been to raise the maximum frequency of transistor oscillation. Here, while low microwave frequencies have been reached[1], the amount of power available has been smaller and smaller as f_{max} is increased. Furthermore, stabilization of transistor oscillators at these frequencies is difficult, its degree unsatisfactory.

The indirect approach consists of multiplying the output signal of a low frequency, well stabilized, high power transistor oscillator-amplifier combination by means of nonlinear elements such as variable capacitance semiconductor diodes (varactors).

Harmonic Generation by Varactors

The theoretical high efficiency of varactors used as harmonic generators has been shown by Manley and Rowe[2]. Other analytical investigations and experiments made to validate this hypothesis have been given in recent literature.[3,4,5,6] These reports have characterized the internal parameters of a varactor which would yield high efficiency in converting low frequency power to microwaves. A satisfactory equivalent circuit for this type of diode is shown in Fig. 1. From a theoretical standpoint, the primary element which produces losses in the diode is the spreading resistance R_s, if the value of the barrier resistance R_d is large over the reverse bias region of the diode. Therefore, a low R_s is required for high conversion efficiency. Also, of course capacitance non-linearity with voltage is necessary.

Finally, considering the power handling capability of the diode, the breakdown voltage must be high as shown in the following expression:[7]

$$P_{av} = \frac{\delta W_1 C_{av}}{4} V^2_{breakdown}$$

where δ is a constant determined by the capacitance nonlinearity and the desired harmonic number, generally $\delta < 1$); W_1 is the input frequency; $V_{breakdown}$ is the diode breakdown voltage; and C_{av} is an average value of the diode capacitance over the operating region.

It was found that a satisfactory answer to these requirements could be found in a structure very similar to the Philco microalloy diffused base transistor[8], by building a diode utilizing only the base collector-diode of this type of transistor. Fig. 2 shows a cross-sectional view of a Philco experimental harmonic generator diode.

The main contributor to the value of R_s is the bulk resistance of the material between the ohmic base contact and the collector dot. It is evident from the physical structure of this type of device that

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JURI VILMS has been a co-op student engineer in the Solid-State Circuit Section of Philco's Research Division since August, 1959—while studying for his B. S. in E.E. at Drexel Institute of Technology. He is a native of Viljandi, Estonia.

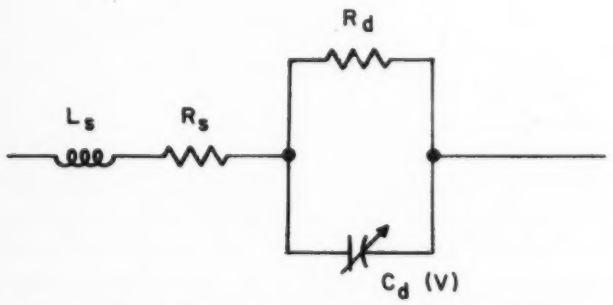

FIG. 1. EQUIVALENT CIRCUIT, Varactor Diode.

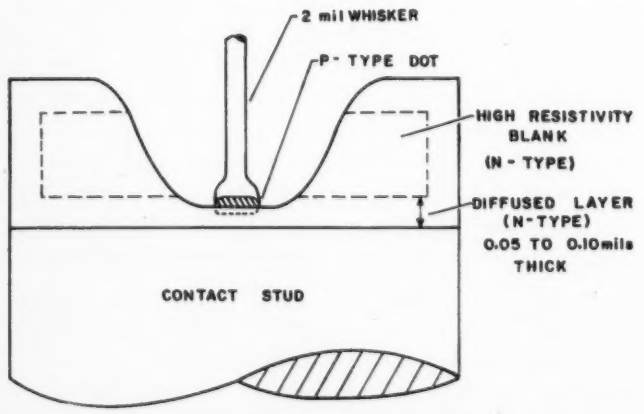

FIG. 2. CONSTRUCTION DETAIL, Philco Varactor Diode.

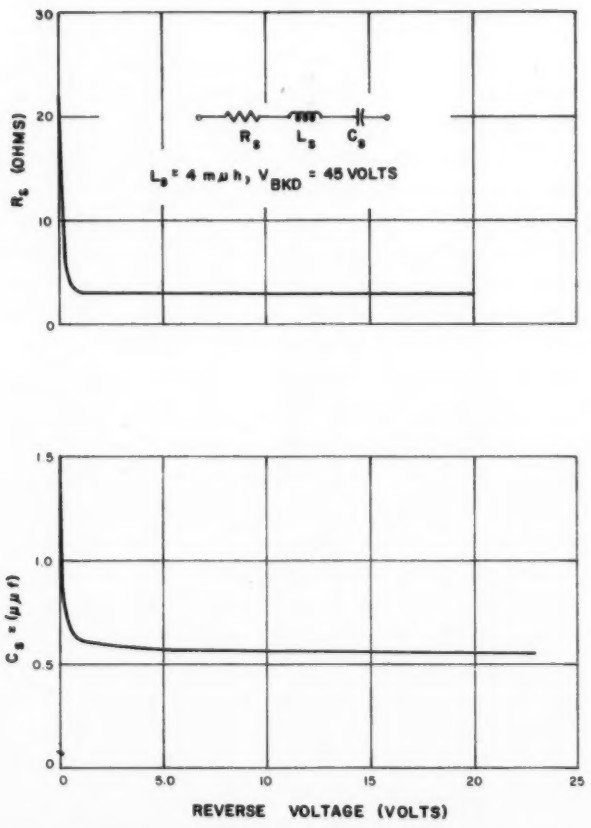

FIG. 3. SERIES RESISTANCE (R_s) and Series Capacitance (C_s) vs. Voltage for Philco Experimental Harmonic Generator Diode.

the value of R_s can be made as low as a few ohms. This structure also affords high voltage breakdown and a capacitance variation of the type shown in Fig. 3.

Experimental Diode Performance

Fig. 3 shows plots of C_s and R_s versus reverse voltage for an experimental harmonic generator diode. Fig. 4 shows the conversion efficiency versus harmonic number for the same diode. Table I compares the performance of several diodes as 400mc and 2kmc (fifth harmonic) generators at $P_{in} = 15$mw, with pertinent internal device parameters.

The data of Table I and other results are encouraging for several reasons. First, it is evident that a reasonable degree of optimization of the device parameters for harmonic generation has been achieved in the best units.

Second, understanding of the device requirements has been strengthened and improved. The necessity for a low series resistance at low voltage (which is also the region of high capacitance) has been verified, because this is the parameter which has shown the most direct and consistent correlation with good performance.

Also, as higher power levels are used, a high reverse breakdown voltage becomes increasingly necessary.

All-Semiconductor Microwave Power Sources

In order to utilize these diodes in the best manner for producing microwave power, several observations must be made with regard to the structure of an all-semiconductor system.

First, it is evident that the transistor oscillator must be operated at a frequency where its conversion efficiency from dc is still sufficiently high.

Second, it must be noted that, given diodes which have an attenuation of 2.5 db in going from fundamental to second harmonic, and a comparatively smaller attenuation (less than 1db) for each additional harmonic, multiple-step harmonic conversion has a definite advantage in efficiency, if it is desired to multiply the fundamental frequency by a large number.

Following these lines of thought, a harmonic generator was developed to give 3mw of power at 2 kmc. The harmonic generator has two stages of conversion, each to the fifth harmonic. A Philco experimental diode is used in each stage, and the 80mc input is provided by a crystal controlled oscillator which employs one Philco MADT type 2N1158A transistor. The complete power source has an overall (dc to 2.3kmc) efficiency of 4.7%. A block diagram of the power source is shown in Fig. 5.

In order to further increase the overall efficiency of an all-semiconductor microwave power source of this type one can introduce a transistor amplifier between harmonic multiplier stages.

A feasible system of this type is shown in Fig. 6. It will provide an overall efficiency of 11.5% in generating 9mw of power at 2kmc. Although this system has not been evaluated as a unit the performance of each of the stages (oscillator, harmonic generators, amplifier) has been verified. The transistor employed in the amplifier stage at 400mc is a Philco coaxially packaged microwave transistor[1].

Thus we feel that diode design, with harmonic generation as a goal, proves encouraging when associated with the proper system design, because this combination makes possible generation of microwave power with high efficiency.

References

1. M. M. Fortini, G. D. McCotter, M. Walker—"A Coaxially Packaged MADT for Microwave Applications"—Paper presented at the 1959 Electron Devices Meeting in Washington, D. C.
2. J. M. Manley and H. E. Rowe—"Some General Properties of Nonlinear Elements-Part I, General Energy Relations"—Proceedings of IRE, Volume 44, page 904, July, 1956.
3. M. M. Fortini and J. Vilms—"Solid-State Generator for Microwave Power"—"Electronics", Page 42, September 4, 1959.
4. D. Leenov and A. Uhlir, Jr.—"Generation of Harmonics and Subharmonics for Microwave Frequencies with P-N Junction Diodes"—Proceedings of IRE, Volume 47, page 1724, October 1959.
5. C. H. Page—"Harmonic Generation with Ideal Rectifiers"—Proceedings of IRE, Volume 46, Page 1738, October, 1958.
6. D. B. Leeson and S. Weinreb—"Frequency Multiplication with Nonlinear Capacitance-A Circuit Analysis"—Proceedings of IRE, Volume 47, page 2076, December, 1959.
7. D. Leenov and J. Rood—"Large Power Harmonic Generation with a Silicon Varactor Diode"—Paper presented at the 1959 Electron Devices Meeting in Washington, D. C.
8. C. G. Thornton and J. B. Angell—"Technology of Micro-Alloy Diffused Transistors"—Proceedings of IRE, Volume 46, Page 1166, June, 1958.

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TABLE 1. INTERNAL PARAMETERS OF EXPERIMENTAL DIODES USED AS FIFTH GENERATORS. Units No. 1, 3, 4 and 5 are Philco Experimental Diodes.

$P_{in} = 15$ mw, $f_{in} = 400$ mc, $f_{out} = 2$ kmc.

DIODE NO.	CONVERSION LOSS (5th HARM.) DB	AT 0.25 VOLTS R_s ohms	AT 0.25 VOLTS C_s $\mu\mu f$	AT 5.0 VOLTS R_s ohms	AT 5.0 VOLTS C_s $\mu\mu f$	BREAKDOWN VOLTAGE VOLTS
1	12.0	35	0.52	4	0.33	80
2	11.0	30	0.76	30	0.30	75
3	7.0	14	0.90	4	0.60	75
4	6.0	8	1.30	5	0.92	30
5	4.5	6	0.76	3	0.58	45

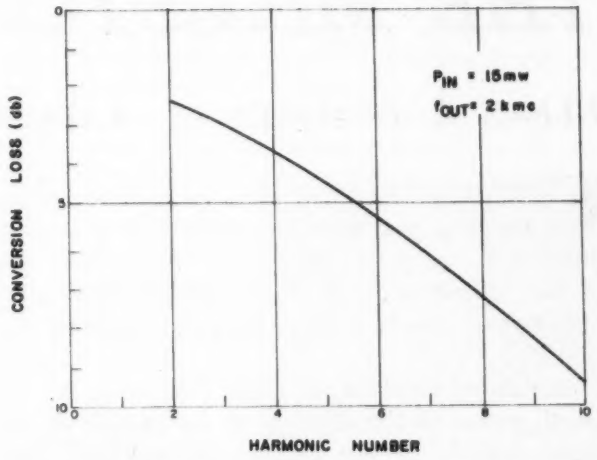


FIG. 4. CONVERSION LOSS vs Harmonic Number for good Philco Diode.

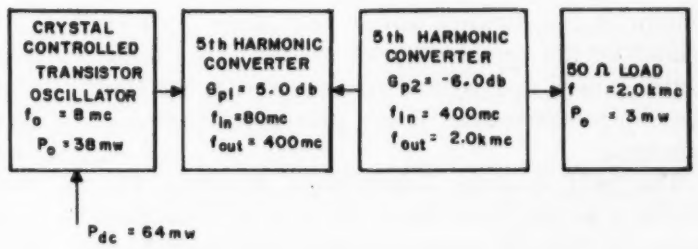


FIG. 5. SEMICONDUCTOR POWER SOURCE, 3 mw output at 2 kmc.

Overall Efficiency = 3/64 = 4.7%

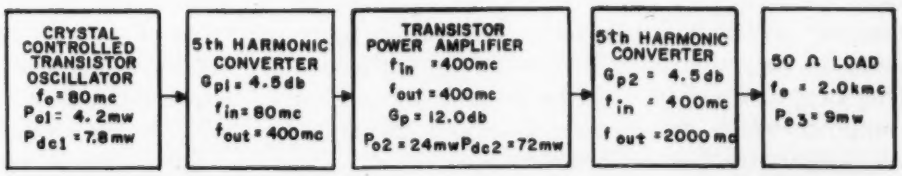


FIG. 6. HIGH EFFICIENCY SEMICONDUCTOR 9mw, 2 kmc Power Source.

Overall Efficiency = $P_{o3}/(P_{dc_1} + P_{dc_2}) = 9/(7.8 + 72) = 11.5\%$

The conquest of outer space has necessitated the developent of missile-borne electronic equipment which combines the precision of a micrometer with the ruggedness of a sledge hammer. Severe environmental conditions, minimum weight, size and power consumption plus maximum possible reliability and operational capability combine to offer today's equipment designer a challenging problem. The Millstone Transponder System, the subject of this article, was designed with all these factors in mind. This article describes the design considerations involved, environmental and operational requirements, and the final configuration for the already flight-proven equipment.

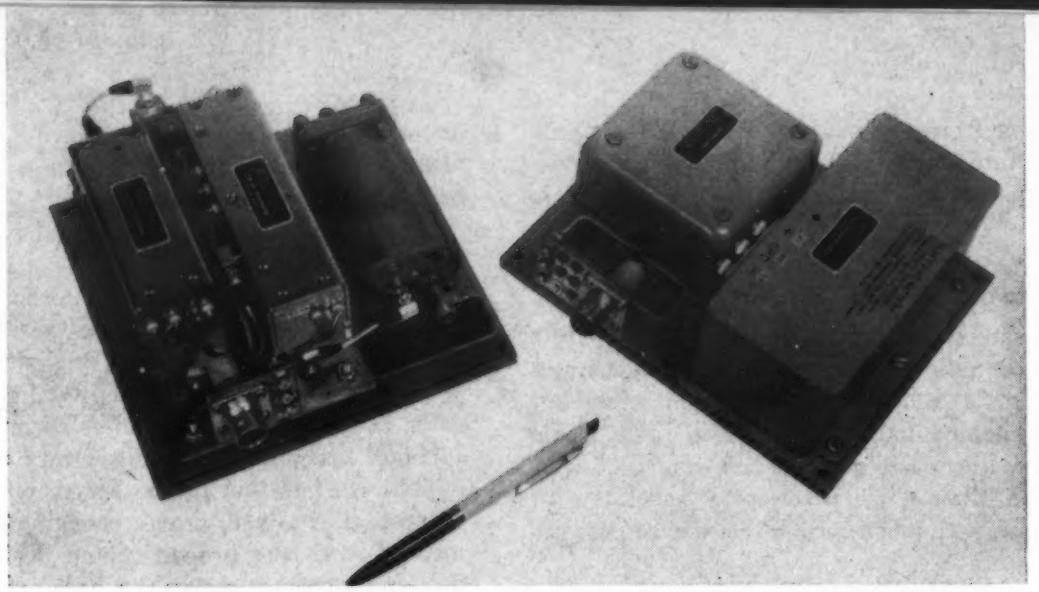


FIG. 1. MISSILE TRANSPONDER for Millstone Radar (MIT) System operating in the 450 mc band consists of RF Unit (left) and Video-Power Unit (right) containing battery power for 40 hr operating period.

THE MILLSTONE TRANSPONDER SYSTEM

GLENN E. PENISTEN and ***LAFE R. PFEIFER, JR.,*** Missiles Dept., Texas Inst. Inc.

COMMUNICATIONS with space vehicles for tracking purposes has become increasingly difficult as we probe deeper into space. The size of the vehicle to be tracked coupled with interplanetary distances makes radar skin tracking impossible.

The signal received on earth diminishes by the fourth power of the distance to the vehicle as the signal travels to the vehicle, is reflected, and travels back. The tracking range can be greatly extended by incorporating a receiver-transmitter in the vehicle which will receive the radar signal and retransmit a signal back to the ground radar receiver. The signal now is diminished by only the square of the distance power and range is determined by the combination of ground radar transmitter power and vehicle receiver sensitivity, and the vehicle-transmitter power plus ground-receiver sensitivity.

The MIT Lincoln Laboratories Millstone Hill Radar is an excellent choice for a ground tracking radar. Its high RF power output in the 400-500 mc region plus its 85-ft scannable antenna permits reception at long ranges without complicated, narrowband, phase-locked receivers. The Millstone Radar receiver sensitivity approaches theoretical maximum for reception from low-power transmitters at long ranges. Coupled with the radar is a real-time computer which provides accurate and almost instantaneous tracking information.

The Millstone Transponder System was designed by Texas Instruments from an original Lincoln Laboratories (MIT) concept to be used in conjunction with the MIT Millstone Radar. This equipment extends the tracking capability of the Millstone Radar to distances in excess of 40,000 nautical miles and provides the accuracy so necessary in vehicle satellite tracking. It is the first completely solid-state device transponder operating in the 440 mc region and uses advanced circuitry and packaging techniques with great success to satisfy all environmental demands of missile-borne equipment.

Transponder Conformation

The complete transponder, pictured in Fig. 1, is comprised of 40 transistors and diodes plus associated components. One package, the RF unit, contains the filter, duplexer, mixer, 30 mc IF amplifier, 2nd detector, local oscillator, and transmitter. The second package, the video and power supply unit, contains the video bandwidth filter, video amplifier pulse width discriminator, accurate pulse generator, modulator, and batteries sufficient for 40 hours continued operation. The complete transponder system weighs only 6.34 lb including batteries. The maximum dimensions including mounting base plates are 2.75″ x 6.59″ x 7.37″ for the video and power supply unit and 3.96″ x 7.15″ x 6.75″ for the r-f unit.

The components for the RF circuitry are mounted in individual modules, usually by stage or function, and then potted into place. Fig. 2 shows a typical module and the components which are to be assembled inside it. This construction technique provides the ultimate in shielding as witnessed by the fact that the transponder has operated without false triggering or saturating when subjected to high levels of RF energy from radar transmitters of C through X band. This is virtually impossible with any other packaging technique and represents an advance in the state of the art in packaging miniaturized RF circuitry. Other advantages of this packaging technique are minimum volume, ease of assembly and alignment, and interchangeability of modules which contributes to productivity. Circuitry thus packaged is extremely rugged as evidenced by the fact that RF modules in the Millstone Transponder System have successfully withstood vibration inputs up to 100 G.

Receiver-Modulator Circuit

Fig. 3 shows a block diagram of the transponder. The signal received at the antenna is filtered by a band-width filter and then enters a strip-line duplexer, which directs the received signal from the filter to the mixer, the transmitter output to the filter, and the local oscillator signal to the mixer. A secondary function is to provide the proper load to the filter, transmitter, and local oscillator. The 30 mc output of the mixer is amplified in a hard-limited, 6 stage, 100 db gain amplifier of 1 mc bandwidth. Gain stability of the amplifier is better

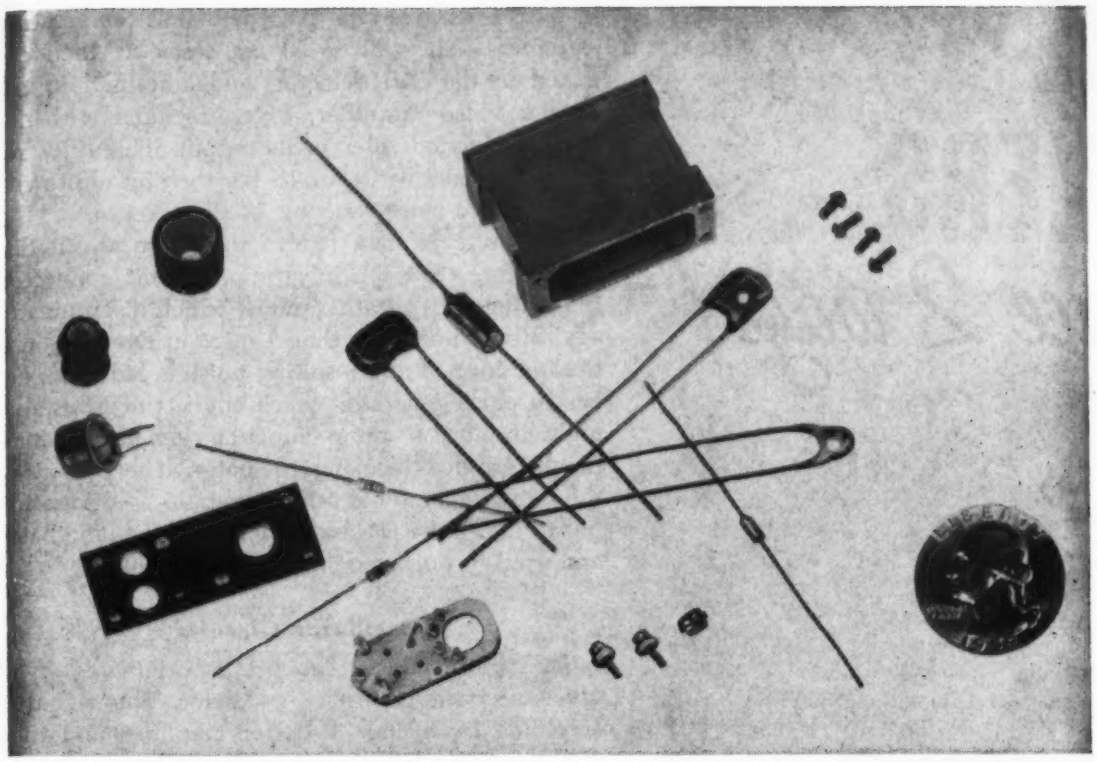
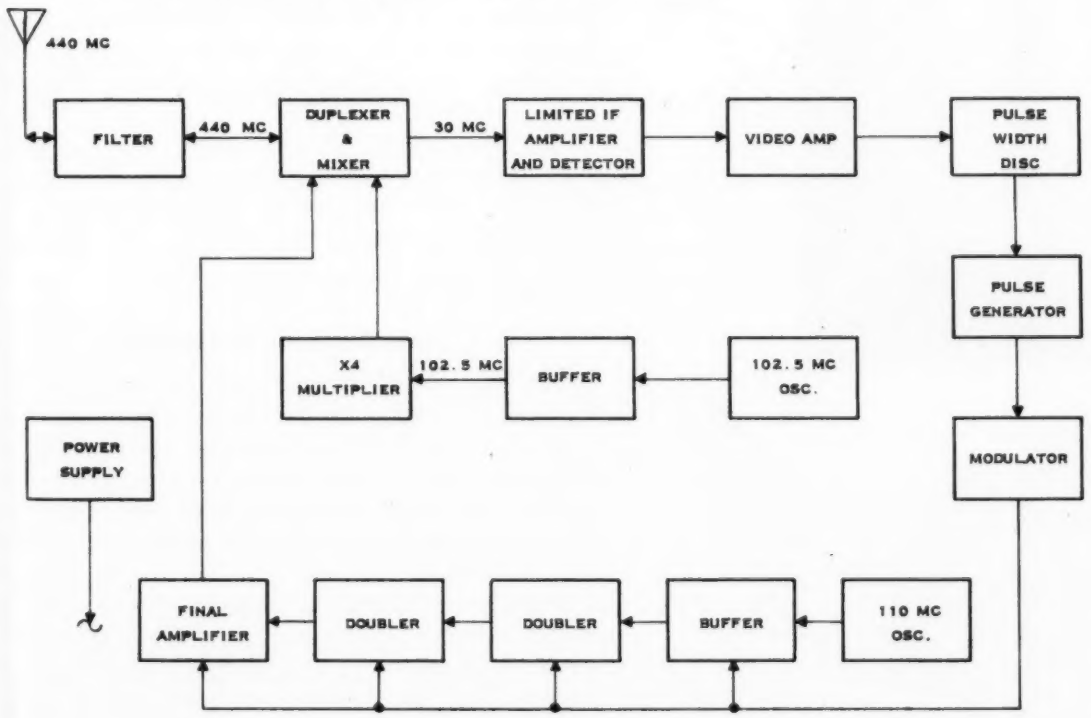


FIG. 2. COMPONENTS ENCAPSULATED in single module of circuit are compared with "two-bits" for size. Vibration immunity to 100 G and excellent RF shielding are gained by this construction.

FIG. 3. STABILITY AND RELIABILITY are features of All-Solid-State circuit designed for high efficiency although weight and space are minimized.



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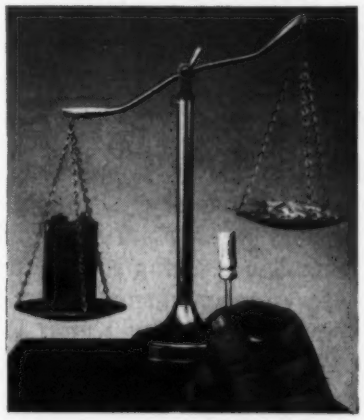

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than ± 3 db over the environmental temperature extremes). The pulsed 30 mc signal is then detected in the 2nd detector, and amplified in the 2-stage video amplifier which includes a bandwidth reduction filter in its output. This filter reduces the bandwidth to 18 kc, thereby improving the signal-to-noise ratio by 14 db.

The pulse is then fed to the pulse width discriminator, a double integration circuit connected in parallel with a gating diode, which discriminates against any pulse less than 1 msec in duration. The trailing edge of any resulting pulse is fed to an accurate pulse generator which consists of a bistable multivibrator, a ramp function generator, comparator, and a blocking oscillator. The output of the pulse generator is a 2 msec ± 15 μsec duration pulse. This pulse is then amplified in the modulator and used to pulse-modulate the transmitter.

Oscillator Circuits

The transmitting frequency is originated by a 110 mc, crystal-controlled oscillator. This signal is amplified by a class-A buffer amplifier and then doubled twice in class-C doubler circuits. The resulting signal is amplified in a class-A transistor final amplifier whose output is approximately 40 mw at 440 mc. The buffer, doubler, and final amplifier receive their collector and emitter voltages from the modulator, accomplishing pulse modulation.

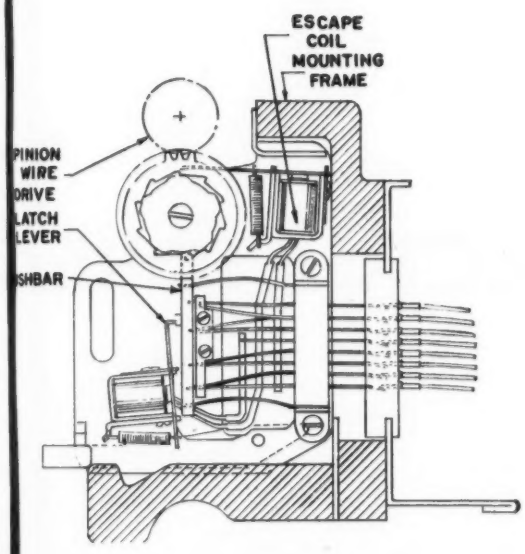
The local oscillator signal is generated at 102.5 mc by a crystal controlled oscillator. It is then amplified in a class-A buffer amplifier. This signal is then fed to a times-four (x4) varactor multiplier which is very efficient, drawing no dc power. It comprises a variable reactance diode and a high Q filter tuned to the fourth harmonic of the incoming signal. The resulting 410 mc signal is directed to the mixer by the duplexer.

Power for the complete transponder is furnished by a twenty-cell buildup of Yardney type HR-1 silver-zinc cells connected to furnish + and — 15 volts. Sufficient power is available for approximately 40 hours of operation.

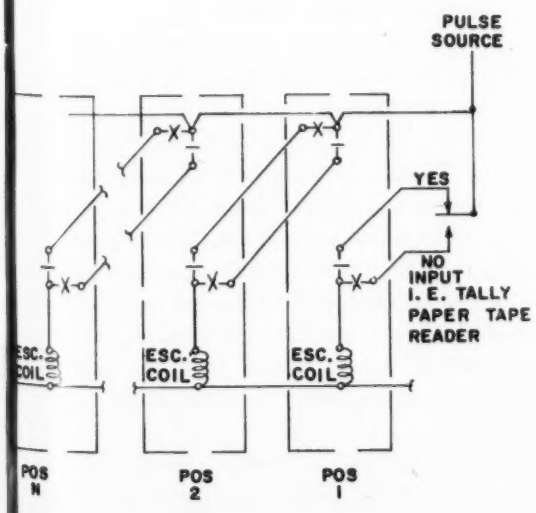
Circuit Features Reliability

Circuitry and packaging evolving from the design and development of the Millstone Transponder paves the way for many reliable applications of transistors and varactor multipliers in RF circuits suitable for space communications and tracking. From a complete stress analysis of the system, the calculated mean-time-before failure for the system is 2,500 hours (excluding battery) based upon a prelaunch time of 6 hours and a flight time of 4 hours. Probability of successfully completing a mission of 6 hours prelaunch time and 4 hours flight time is 99.6% (including minimum 40 hour battery life).

Bi-Stable Logic Switching



DELAYED LOGIC Switch operation simplifies design of low-resistance logic circuitry, utilize motor power for driving of actual contactors as programmed by logic circuitry.



Tally logic switches have the following advantages over standard relays in delayed logic circuitry: (1) They can perform functions which cannot be economically performed by standard relays; (2) consistently reliable and repeatable operate and drop-out times simplify design and logical analysis; (3) low-resistance circuitry can be used to implement logic; and (4) switches sense their own bistable state with their own contacts.

Tally switches are packaged in a shelf which makes the proper connections, provides mechanical linkage to rotating clutch members (Pinion Wire Drive), and includes a fractional horsepower motor to drive clutch members.

The schematic circuit represents a series of logic switches arranged to function as a shift register. In this application, each incoming pulse shifts the information (position state) position 1 over to position 2, the information in position 2 over to position 3, etc.

The first pulse to arrive compares the state of the input switch with that of the logic switch in position 1. If the states agree, no action is required. If they do not agree, the need for a change is momentarily "remembered" but not yet "executed". *At the same time, with the same pulse,* the still unchanged state of logic switch 1 is compared with that of logic switch 2. If a change is needed, this is remembered by logic switch 2 but not executed.

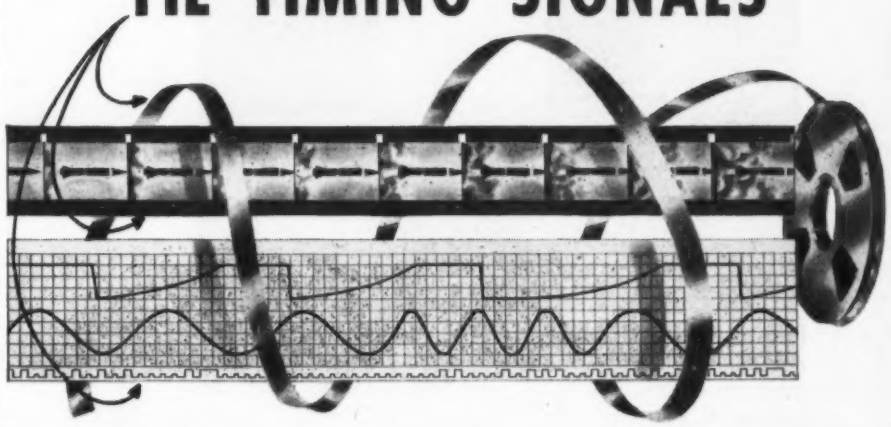
Similarly, down the line, the same pulse causes logic switch 2 to be compared with switch 3, switch 3 to be compared to switch 4, etc. Any changes needed to pass the information one position along are "remembered" for later action.

After the pulse has expired, those elements which need to be changed are switched by action of the motor driven pinion where escapement and latch position allow this change. All others remain unchanged. A second pulse, which can arrive as early as 16⅔ ms after the first, would similarly pass the contents along and set the first position to agree with the new state of the input switch.

As a consequence of the delayed action of Tally switches, all circuits are switched in so-called "dry" condition, leading to unusually good contact life and ratings. (*From information in new 8-page brochure, "Tally Logic Switches", Tally Register Corp., 5300 14th Avenue, N. W., Seattle 7, Wash.*)

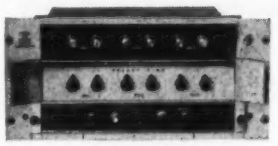
FOR THIS LITERATURE CIRCLE 98 ON READER-SERVICE CARD

TIE TIMING SIGNALS

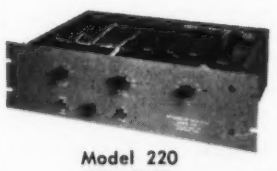


to different recording media with

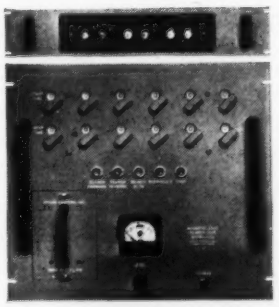
HERMES TIMING EQUIPMENT



Model 270
DIGITAL
TIMING GENERATOR



Model 220
RETARDED
BIT RATE UNIT



Model 202
MAGNETIC
TAPE SEARCH UNIT

Hermes Timing Equipment is specifically designed to correlate precise timing signals with data on different recording media such as recording cameras, plotting boards, strip charts and high or low speed oscillographs. This timing equipment consists of a Digital Timing Generator and Retarded Bit Rate Unit which operate during periods of data acquisition and a Magnetic Tape Search Unit which operates during periods of data reduction.

Digital Timing Generator, Model 270, is an all solid-state instrument which generates binary coded decimal signals as recorded on magnetic tape providing a precise digital index in terms of elapsed time. The Generator also visually displays the exact time in hours, minutes, and seconds as illuminated digits. An Airborne Digital Timing Generator, Model 206A, which meets all the essential requirements of MIL-E 5400 is also available.

Retarded Bit Rate Unit, Model 220, operates in conjunction with Timing Generators, Models 270 or 206A, to provide a pulse-height, pulse-width signal, for recording time on equipments other than magnetic tape recorders.

Magnetic Tape Search Unit, Model 202, is used to control a magnetic tape transport during periods of data reduction for automatically searching the tape on the basis of time indices previously recorded by any one of the two Timing Generators. The Retarded Bit Rate Unit, Model 220, can also be used with Model 202 for reproducing time on oscillographs as previously recorded on the tape.

Auxiliary equipment including a Run Code Selector, Model 225, for inserting data run code numbers and a Tape Input Programmer, Model 230, for automatically programming tape search are also available.

Write for Technical Bulletins on Hermes Timing Equipment.

Hermes Electronics Co.

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CIRCLE 22 ON READER-SERVICE CARD

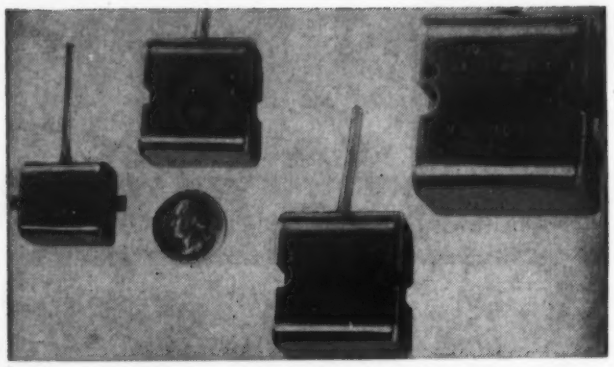

FIG. 1. RUGGED ELECTROMECHANICAL ACTUATOR, the Flat Armature Torque Motor, is widely used in electro-hydraulic, electro-pneumatic and hot gas servo systems.

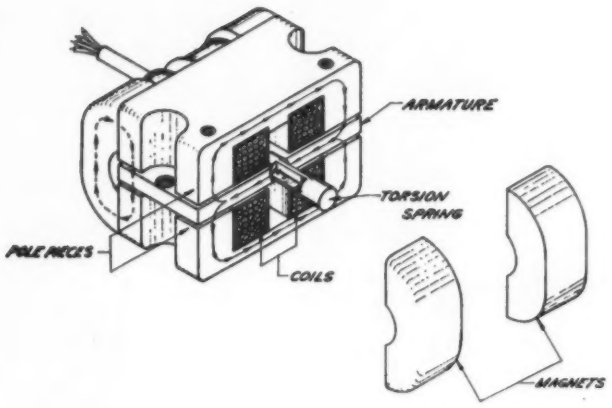

FIG. 2. TORQUE MOTOR Configuration.

TABLE I. PERFORMANCE CHARACTERISTICS, SERIES 20 FLAT ARMATURE TORQUE MOTORS.

MODEL	20-1	20-2	20-3	20-4
Stroke (in.)	±.006	±.007	±.008	±.015
Output Radius (in.)	.650	.593	.750	.906
Midposition Force (lb.)	2.5	5.0	8.0	13.0
Hysteresis (%)	2	2	2	2
Resonent Frequency (CPS)	940	790	580	400
Max. Power Req'd (Watts)	1.6	2.65	3.1	5.2
Weight (oz.)	2.8	5.8	8.8	18.5

SMALL DISPLACEMENT ELECTROMECHANICAL ACTUATORS

NICHOLAS D. TRBOVICH, President, Servotronics, Inc.

The flat armature torque motor (Fig. 1) is a small displacement electro-mechanical actuator. Designed and constructed to provide a linear displacement and output force proportional to the input control current, this actuator is utilized extensively in electro-hydraulic, electro-pneumatic, and hot gas servo systems. The flat armature torque motor when incorporated into a control system provides a most reliable and rugged control component.

Torque Motor Operation

A diagram of a typical flat armature torque motor is illustrated in Fig. 2. The armature of this device is supported by two shafts which serve as torsion springs. Various mechanical spring rates of the shafts are obtained by varying the web thickness of the machined cruciform section. The shaft is rigidly affixed to both the armature and the stainless steel frame of the torque motor, which insures infinite resolution. Two coils, located on the armature on either side of the cruciform section, are wound in opposite directions The permanent magnets of the torque motor provide the polarizing flux which assumes the path indicated by the dotted lines in Fig. 2. The permanent magnet flux also serves to reduce the mechanical spring rate. In other words, the permanent magnet has the effect of a negative spring which subtracts from the stiffness of the mechanical spring.

The solid lines in Fig. 2 indicate the flux path due to the application of input control current of one polarity to the two coils. The control flux due to this input current is reinforced by a portion of the polarizing flux from the permanent magnets. The differential current produces an increase of magnetic flux in two of the four air gaps and a corresponding decrease in the remaining two. The armature of the torque motor will then rotate in the direction of the increased flux level and will assume a stable position at the point where the centering force due to the torsional spring equals the force resulting from the input control current.

Linearization Techniques

Several approaches have been attempted to minimize the "square law effect" in the linearization of torque motors. One of these approaches has been controlled saturation of the armature by reducing its cross section. Although this method will increase the linear portion of the no-load displacement curve by as much as 10%, there is a substantial loss in midposition force or force available to drive a load. Therefore, this method of linearization is not recommended unless the output force desired is relatively unimportant. The most widely acceptable and convenient method of obtaining a linear output is by designing the air gaps to be sufficiently large with respect to the desired displacement. Mechanical stops are usually incorporated to insure no more than the desired output. In this manner, the "square law effect" shown by a rapid increase in gain at the end of the armature stroke is minimized to a practical limit (Fig. 4).

Torque Motor Rating

The midposition force of a permanent magnet torque motor is that force that the torque motor will produce at its neutral position when rated input current is applied. This force level is utilized as a means of rating a torque motor. Approximately ½ of the mid-position force is available at the end of the armature stroke. This is obtained by adjusting the mechanical spring rate of the torsion spring so that full unloaded displacement is provided at 35% to 40% of rated current. Fig. 3 illustrates a typical mid-position force curve for a torque motor with a rated 5-lb output.

In practical applications, a torque motor is usually working into a load (either constant or vari-

able). The output characteristics of a torque motor when it is incorporated into a system is best illustrated in Fig. 4. The solid lines are the output displacement curves of a typical torque motor when it is operating into a constant load of various magnitudes. However, as is more often the case, the load is variable with respect to displacement (i.e. the Bernoulli force acting on a hydraulic control spool; the opening and closing of a nozzle). When this occurs, the output of the torque motor assumes the curve as indicated by the dotted line. It should be emphasized that Fig. 4 is a typical curve to be expected from a torque motor that does not incorporate saturation of the armature to gain its unloaded displacement linearity. If the armature saturation were utilized, the succeeding family of curves at various load levels would saturate earlier thus limiting and distorting the output.

Dynamic Response Characteristics

Inherently, flat armature torque motors have very high dynamic response. This feature is due to the very low inertia of the armature. Its very high natural frequency (several hundred cycles per second) enables it to be incorporated into systems without any damping. It is recommended that the torque motor be driven from a high impedance source to realize the optimum in frequency response characteristics (Fig. 5).

Torque Motor Applications

The most common utilization of the flat armature motor is to directly drive a hydraulic control spool in a single stage servo valve. Because of its design symmetry, the armature of the torque motor is very easily mass-balanced and rendered insensitive to acceleration forces.

The weight and size of a torque motor is determined primarily by its performance requirements. Although a family of "off the shelf" torque motors (Fig. 1) are available with various performance characteristics (Table I) which will fulfill the specifications of the majority of applications, frequently specific requirements require custom designed torque motors. In these cases, the torque motor can usually be constructed to take advantage of the peculiarities of the system in which it is to be incorporated. An illustration of this is the design of a torque motor to be utilized to control the hydraulic or pneumatic pressure in a pair of nozzles as illustrated in Fig. 6. Under this condition, the torque motor is operating into a load which varies with respect to its displacement. This type of load can be equated to the mechanical spring of the torque motor. Thus, if this spring rate is known, the net spring of the torque motor can be reduced by that amount.

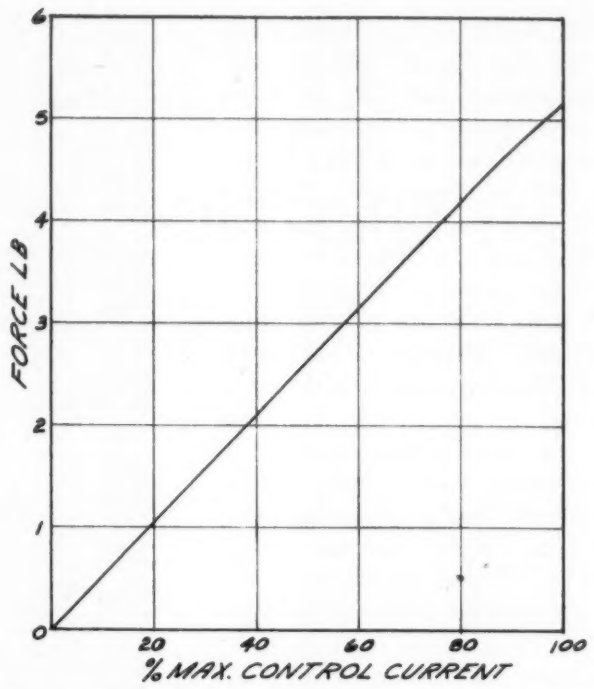

FIG. 3. MIDPOSITION FORCE Curve for Flat Armature Torque Motor with 5 lb rated output.

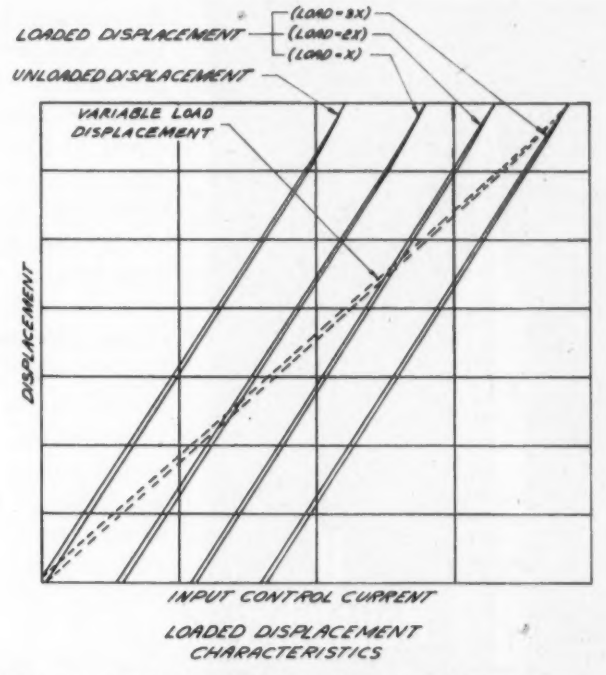

FIG. 4. LOAD-CURRENT DISPLACEMENT Curves for typical Flat Armature Torque Motor.

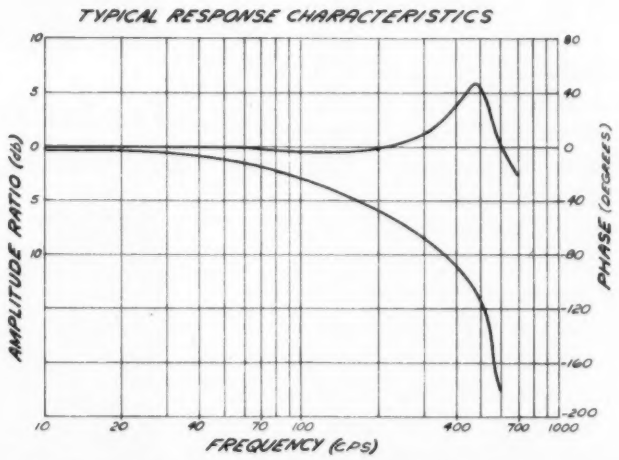

FIG. 5. HIGH DYNAMIC RESPONSE enables Flat Armature Torque Motors to be incorporated into Servo Systems without damping.

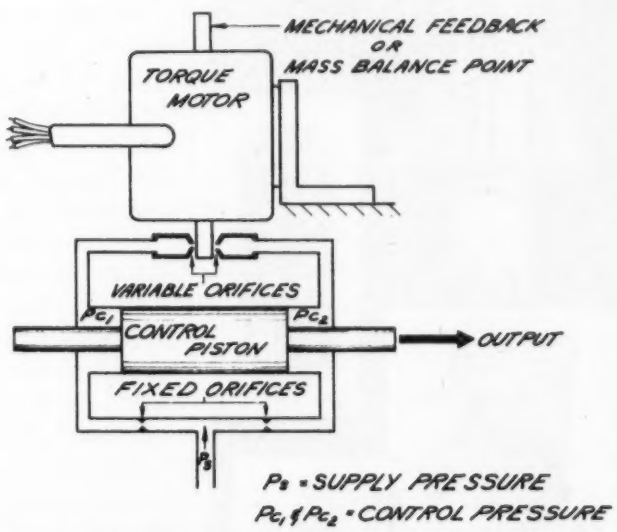

FIG. 6. TORQUE MOTOR Application in Electro-Pneumatic Two-Stage Servo.

This approach has been utilized to a great extent in the design of two-stage servo control valves.

The effects of virtual cancellation of the torque motor mechanical spring-rate by its magnetic spring rate can be better appreciated by considering the result of completely removing the torsion spring from the torque motor. The armature would then be in a state of conditional stability. With any input or disturbance the magnetic force would completely displace the armature in one direction, and close one nozzle. This nozzle would remain closed until the control pressure became greater than the magnetic force. The armature would then completely close the opposite nozzle and repeat the process. This process yields the fastest possible presure response.

In practice, the mechanical spring is weakened rather than removed in order to insure valve and system stability. The mechanical spring characteristics should approximately cancel the slope of

the magnetic force characteristics. The armature will then completely close the nozzle with the application of an input current and hold it closed until the control pressure creates an opposing force equal to the net force created by the input current. The armature will then reposition itself to maintain this control pressure. The opposite end of the armature (Fig. 6) can be utilized to either mass-balance the torque motor or to complete a mechanical feedback loop. This type of force transducer action is particularly desirable in pneumatic systems which require high response in addition to overall system linearity.

Servotronics, Inc. has also custom designed a sealed torque motor which has a linear output in excess of 0.012 of an inch at a power input of less than 0.1 watt. This unit was designed in such a manner that all motor components including the armature and coils are isolated from the environment of the operating medium it is controlling. Therefore, any contaminant in the operating medium (whether it be hydraulic oil or jet fuel) will not effect the operation of this unit. The complete torque motor weighs only approximately 2.8 ounces. Such a torque motor is particularly useful in the control of hydrogen peroxide.

Torque motors have also been utilized with success on tape seekers for computers. The tape is threaded between a roller (which is connected to the torque motor armature) and a capstan pulley which is driven at a constant high speed. When the tape is to be engaged the torque motor is energized. Its armature displacement forces the tape into intimate contact with the capstan, resulting in instantaneous tape movement at a high velocity. The high dynamic response of the flat armature torque motor makes it particularly desirable in this application. A high performance control unit has been constructed for a hot gas application utilizing a suspension plate valve and a torque motor. The standard Servotronics' torque motor operates continuously in ambient temperatures of 450°F. Specialized torque motors to operate in excess of 700°F have also been constructed to meet specific requirements. Development work to build torque motors to operate continuously in excess of 1000°F is now in process at Servotronics, Inc., 190 Gruner Road, Buffalo, 25, N. Y.

Equally as important as the high performance and output of the torque motor is its reliability and ruggedness. The Servotronics' Model 20 series torque motors combines the maximum of ruggedness, low weight, and high performance, made possible by its "unitized" construction. Pole pieces, magnets, coils and armature are rigidly contained and affixed to a non-magnetic stainless steel frame to eliminate breakage or operational instability under shock or vibration.

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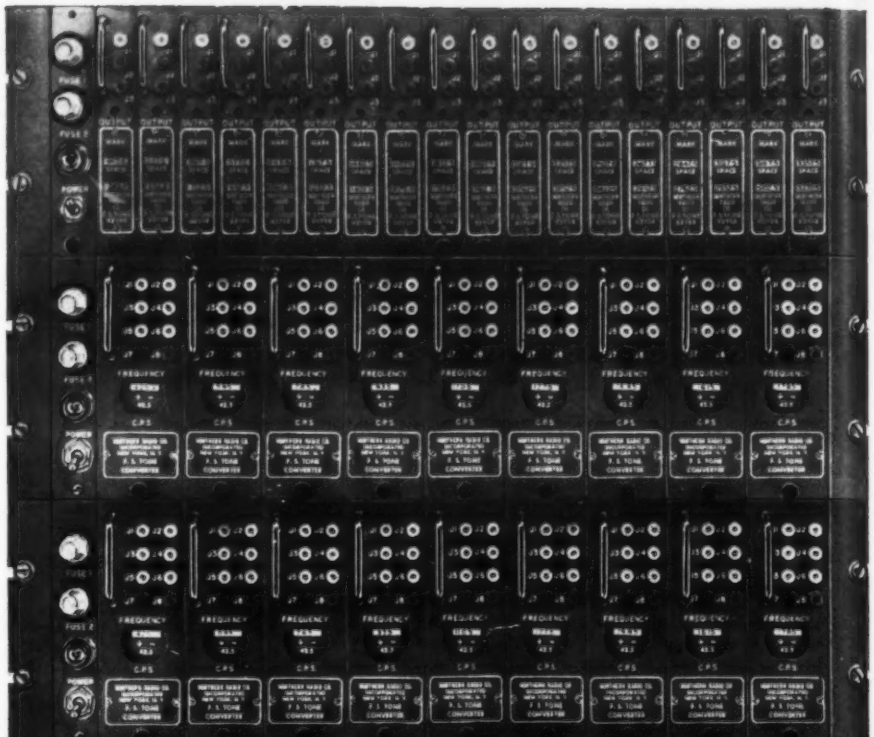

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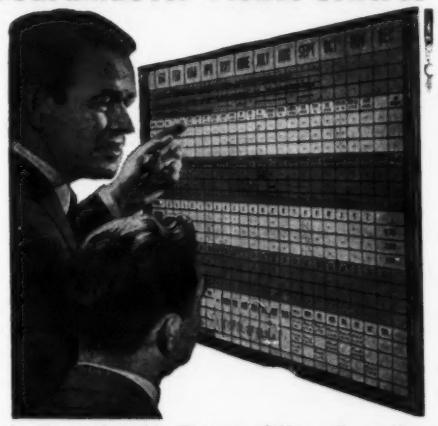

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CIRCLE 26 ON READER-SERVICE CARD

FLUSHING COPPER CONDUCTORS IN PRINTED CIRCUITS

GEO. J. MULLER, Taylor Fibre Company

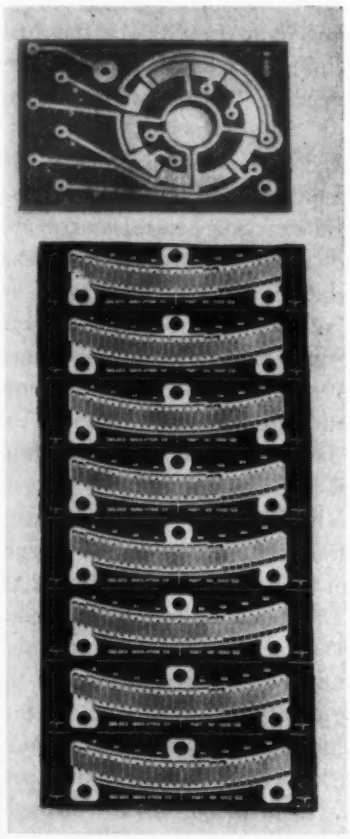

FIG. 1. FLUSHING etched panels minimizes arc draw and edge wear if the circuit is a part of a sliding contact.

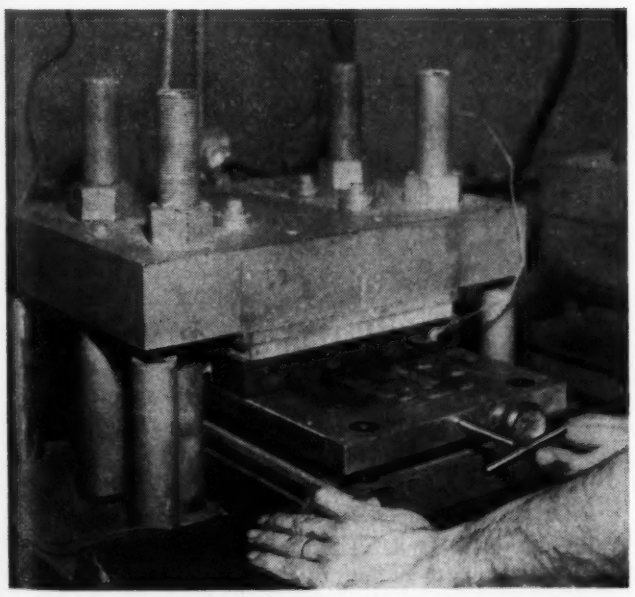

FIG. 2. HYDRAULIC PRESS with heated platen is used to flush circuits. Second cold press for cooling flushed circuit while still under pressure may be used to speed production.

FLUSHING etched panel wiring—pressing the copper conductor to bring it flush with the base laminate—minimizes arc draw and edge wear when the circuit is part of a sliding electrical contact. When given this protection the area of electrical contact remains constant.

Although there is no standard method for flushing etched circuits, the Engineering Department of Taylor Fibre Co., Norristown, Pa., recommends a procedure which, with variations to suit particular circumstances, will prove best under most conditions.

To test the degree of flushing, a stylus with a crystal pickup may be run over the flushed surface. With the output of the pickup connected to an oscilloscope, a straight line will be displayed if the circuit is perfectly flush. If it is not, the obstruction will cause a "blip" in the line. A similar method can be used to detect obstructions audibly. Another quick method is to run a fingernail across the circuit. It should not catch on the copper. A good flushed circuit should have no voids around the edges of the copper and no appreciable reduction in the thickness of the laminate. Typical flushed printed circuits are shown in Fig. 1.

Selection of Base Laminate

The ability to flush an etched circuit successfully depends to a great extent on the base laminate, as some grades are better adapted to this process. For example, etched circuits can be readily flushed when using Taylor's grades XXXP-242, a phenolic resin, paper-base laminate that can be cold-punched up to 1/16" thickness, and GEC-500, an epoxy resin, glass fabric laminate.

The quality of copper is also important. Taylor uses rolled copper foils of better than 99.5% purity, which because of its close grain structure and surface smoothness is ideally suited to receive hard surfacing, like rhodium plating, to increase resistance to sliding wear.

Equipment

Flushing equipment consists of a hydraulic press with platens that can be heated to 450°F and then rapidly cooled. The press must be properly aligned. Also needed are two hardened steel plates, no less than 3/16" thick, of the same size as the press platen. Top and bottom surfaces of these plates must be ground smooth and parallel. Layers of hard kraft paper are also needed for cushioning to compensate for slight irregularities in thickness of the laminate and the copper.

Typical Lay-up

A typical assembly of material to insert in the press is:

1. Four or five sheets of 11-mil kraft paper.
2. A flat-ground steel plate.
3. The etched circuit to be flushed.
4. The second flat-ground steel plate.
5. Four or five sheets of 11-mil kraft paper.

It is advisable to apply a thin film of releasing agent, such as stearic acid or one of the silicone greases, to the steel plates before assembly to prevent the laminate from sticking when hot-pressed. Excess releasing agent should be wiped off with a paper towel before assembly.

Suggested Flushing Procedure

1. Raise platen temperature to 400°F.
2. Insert lay-up.
3. Close press (Fig. 2) to a pre-set pressure of from 500 to1000 psi for phenolic resin, paper base laminate; and 2000-3000 psi for epoxy resin, glass-fabric laminate, as calculated over the total area of the base panel.
4. Maintain pressure and heat for 10 minutes for phenolic-resin, or 20 minutes for epoxy-resin laminates.
5. Holding the lay-up under pressure, rapidly cool the platens to room temperature. This prevents the copper from creeping above the surface of the laminate when the pressure is relieved. An alternate method is to transfer the hot lay-up to a second cold press in which the pressure is again applied. This method accelerates cooling and permits production of a second circuit simultaneously in the hot press. One cold press can thus cool the output of two hot presses.

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BASIC BUILDING BLOCKS FROM KEARFOTT

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This compact new gyro, designed for application in high-performance aircraft and missiles, provides extremely accurate attitude data. Its liquid bubble-type vertical sensing element generates error signals proportional to spin axis displacement from horizontal, while minor wiring modifications permit sensor connection to leveling torquer, completing inner axis leveling loop.

TYPICAL CHARACTERISTICS #A2215

Environmental Capabilities
Vibration:
5g, 20-1000 cps; 10g, 1000-2000 cps
Temperature Range (operative):
—54°C to +71°C
(non-operative):
—65°C to +85°C
Altitude: Unlimited

Azimuth Pickoff
Excitation:
26V, 400 cps, single phase
Output (sinusoidal):
11.8V ± 5% max.
Error from E.Z.: 10 min. max.

Motor
Excitation:
115V, 400 cps, three phase
Speed: 23,500 RPM
Power: Starting: 35 watts
Running: 7.5 watts

Performance Characteristics
Drift: 4°/hr. max.
Leveling Rate:
Between 2° and 4°/min.
Azimuth Torquing Rate:
360°/min. (intermittent)
40°/min. (continuous)

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

VERTICAL GYRO

Kearfott's rugged new vertical gyro, designed for missile application, is a two-degree-of-freedom instrument with 360° of freedom about inner gimbal axis. Self-contained vertical erection system incorporates liquid bubble-type vertical sensing device.

TYPICAL CHARACTERISTICS #B2115

Environmental Capabilities
Vibration:
5 g, 20-1000 cps;
10 g, 1000-2000 cps
Temperature Range (operative):
—54°C to +71°C
(non-operative):
—65°C to +85°C
Altitude: Unlimited

Pickoffs
Excitation:
26V, 400 cps, single phase
Error from E.Z.: 10 min. max.
Output Voltage (line to line):
11.8V ± 5% max.

Motor
Excitation:
115V, 400 cps, three phase
Power: Starting: 35 watts
Running: 7.5 watts

Performance Characteristics
Repeatability of Established Vertical:
To within a cone of half angle equal to 12 minutes of arc
Scorsby Drift Rate in 5 Min. Time:
0.3°/min. (average)
Erection Rate:
Normal: Between 2° and 4°/min.
Fast: 80°/min. intermittent,
40°/min. continuous

Physical Features
Anisoelastic Drift:
0.08°/min/g² at resonance
Weight: 5.5 lbs. (approx.)
Mass Unbalance: 0.1°/min/g

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

FREE GYRO

A highly reliable, two-degree-of-freedom instrument utilizing AC synchro transmitters at each gimbal axis. Designed to operate under the most severe missile conditions, this gyro has AC torquers mounted at each gimbal axis to permit command positioning or slaving of spin axis to desired reference position; each torquer capable of producing a precession rate of 360°/minute with 12.5 watts/phase power input.

TYPICAL CHARACTERISTICS #Q2315

Environmental Capabilities
Temperature Range:
(operative): —54°C to +71°C
(non-operative): —65°C to +85°C
Altitude: Unlimited
Vibration: 10g, 10-2000cps

Pickoffs
Excitation:
26V, 400 cps, single phase
Output (sinusoidal):
11.8V ± 5% max.
Error from E.Z.: 10 min. max.

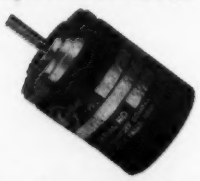
Motor
Excitation:
115V, 400 cps, three phase
Speed: 23,500 RPM
Momentum:
2.25 x 10⁶ gm cm²/sec.

Caging and Preset Provision
(Electrically energized torquer type)
Excitation: 115V max./phase
Torquer Constant:
22.8 dyne cm/Volt²

Performance Characteristics
Free Drift:
5°/minute each axis
Runup Time:
1 minute max.
Torquing Rate:
360°/min. (intermittent)
40°/min. (continuous)

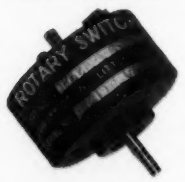
Write for complete data.

Synchronous Motor



Ferrites

Rotary Switch



Engineers: Kearfott offers challenging opportunities in advanced component and system development.

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GENERAL PRECISION INC.

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Higher Mercury Purity For

A MISSILE control engineer, commenting on the pressing need for high-purity materials, has stated that "a multimillion dollar rocket can be lost because a few ounces of mercury vital to the functioning of an ignition tube electrode is contaminated by as little as 3 parts per ten million of a noble or base metal."

Because this Space Age demand is also in line with super clean mercury requirements for other uses in electrical, laboratory and exacting control and instrument applications, the Bethlehem Apparatus Company, Hellertown, Pa. has developed and is now operating a completely automatic three-stage vacuum still.[1] Due to the high operating efficiency and automatic features of this system, super-clean mercury can be produced at no additional cost. To handle volume a second still has been made and installed. Both units are shown in Fig. 1.

Each unit of the still consists of three kettles, eighteen inches in diameter, hung from balance beams; and below them two reservoirs, holding 2000 pounds of mercury. The temperature is controlled thermostatically at 220° C, ±5°. The rate at which mercury is fed from the raw mercury tanks and the burner settings are automatically regulated so that each kettle holds the same quantity, about 150 pounds. At the exit of each kettle (Fig. 2) a spiral trap prevents entrained droplets from being carried through.

[1]Note the term "Triple Distilled" has been so flagrantly abused in the trade that it is meaningless on a label. The user should get direct assurance from a vendor on this point.

FIG. 1. CONTINUOUS TRIPLE-VACUUM Distillation systems for high-purity mercury production are completely automatic. Each triple still produces over 1900 lbs/day of super-clean mercury such as is needed in ignition rectifier control tubes. The transfer buggy holding 600 lbs is being filled by gravity flow.

After passing this trap the mercury vapor escapes through the vertical control pipe to the water-cooled condenser above and thence down the inclined pipe to the next kettle, or in the case of the last kettle, to the reservoir for refined mercury below. All metal parts with which mercury can come in contact are made of stainless steel.

The Hulett principle is used in this still; that is, moist air is bubbled through the mercury in the first two kettles, to oxidize any lead, zinc, cadmium, tin, copper, or other oxidizable metals that may be present. With this admission of air the vacuum is held to 10-15 millimeters.

Since the still is operated continuously, with only occasional supervision during the day and none at all at night, in addition to the normal regulating elements a complete set of emergency controls has been installed. If the water supply should fall or if for any reason one of the kettles should become too light or too heavy within narrow limits, the whole system is immediately cut off. An exhaust fan is pro-

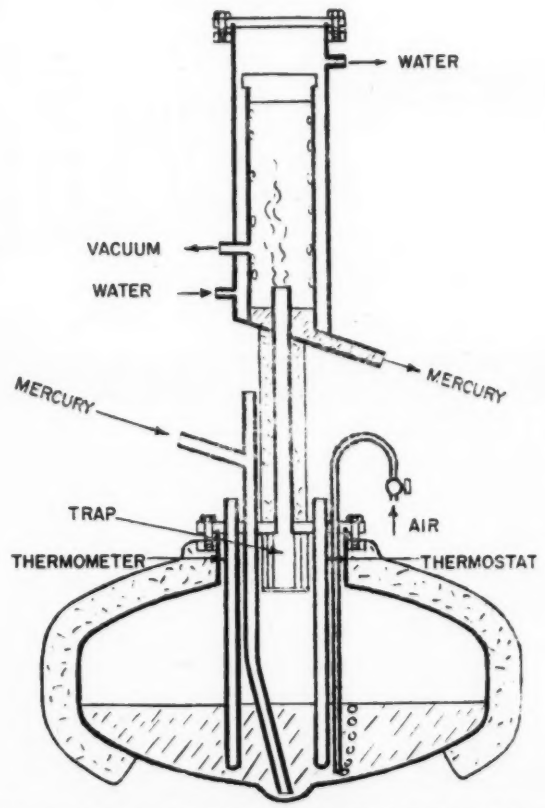

FIG. 2. SINGLE STAGE MERCURY Still and Condenser, Schematic Diagram. Three stages of this type operating in tandem are required to produce the highest purity mercury, needed in missile control systems and other applications.

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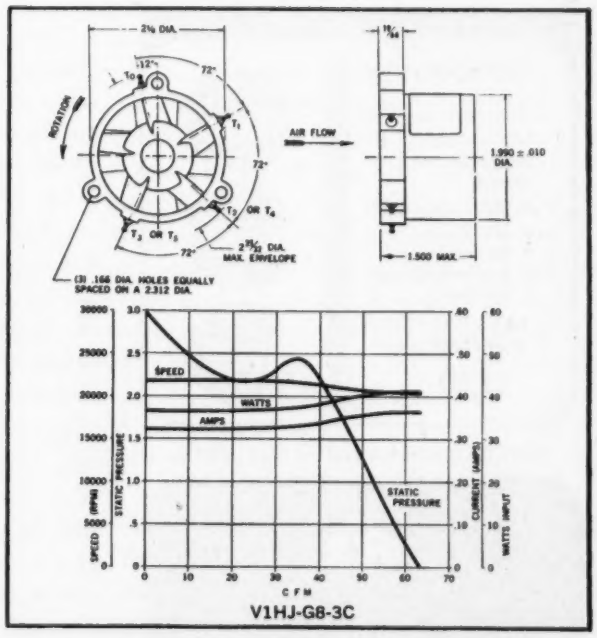
Miniature Vane Axial Blower

This is the newest development in EAD's growing family of "V-LINE" Vane Axial Blowers. Maximum air delivery plus top efficiency (watts in against air out) in an extremely compact package – just 1.5" in total length, less than 2" in diameter. The unique mechanical and aerodynamic design incorporates EAD's highly-reliable 1" diameter motor for highest fan speeds and life in excess of 1000 hours at 125°C. In addition to 2-pole characteristics listed, there are 4 and 6-pole designs and models for operation from 1600-cycle and variable frequency power sources. Meets MIL-E-5272A, MIL-E-5400B, other specifications. Write for complete data on this and other "V-Line" models.

TYPICAL CHARACTERISTICS

- 115 volts, 400 cycles single or three phase
- 19,000 rpm nominal
- 65 CFM at 0" SP
- 35 CFM at 2.3" SP
- 37-40 Watts
- 1.5" total length 1.990" housing dia.
- Available with:
  1. Leads
  2. Terminals on mounting flange
  3. Terminals on housing
- Weight, 4.3 oz.



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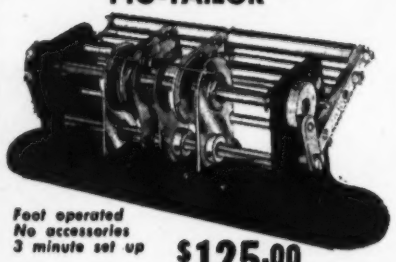

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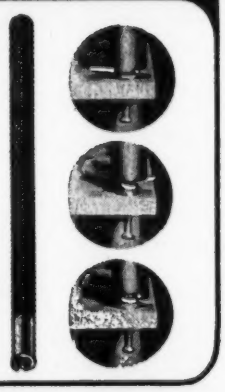

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DESIGNERS & MANUFACTURERS OF ELECTRONIC EQUIPMENT

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CIRCLE 29 ON READER-SERVICE CARD

vided for drawing air from the covered reservoirs to prevent any mercury fumes from escaping into the room.

A transfer buggy shown along the side of the still is used for handling the clean mercury to assure maximum security against contamination. The tank of the buggy, which holds 600 lbs, is filled by a tube passing through a hole in the top. When full, the hole is closed by a screw cap, the buggy wheeled wherever desired and the enlarged head of the discharge tube (containing a heavy filter pad) is held to discharge at the proper location by air pressure applied to the tank. This quickly forces out the mercury, even to a considerable height, until only a couple of ounces remains behind.

Purity Tests are Rigid

The production of each triple still is about 40 lbs an hour which in a 24-hour day amounts to over 1900 lbs. The purity obtained is believed to be very high and certainly meets the most rigid tests available, which are as follows:

TYPICAL ANALYSES ON VACUUM TRIPLE-DISTILLED MERCURY

Batch No.	Evaporation (PPM)	Spectrographic (PPM)*		
		Silver	Copper	Gold
506	0.025	0.1 - 0.3	0.1 - 0.3	ND**
507	0.025	0.2 - 0.4	0.1 - 0.3	ND
508	0.025	0.1 - 0.3	0.1 - 0.3	ND
509	0.075	0.1 - 0.3	0.1 - 0.3	ND
510	0.025	0.1 - 0.3	0.1 - 0.3	ND
511	0.025	0.1 - 0.3	0.1 - 0.3	ND

* Values of 0.1-0.3 PPM mean that the line in the spectroscope is barely detectable and should not be interpreted quantitatively."

** ND (not detectable)

Methods of Analysis

Evaporation test—A composite sample weighing 2000 grams is drawn during the bottling operation from each 1200 lb lot. This sample is evaporated completely in a vacuum of 100 microns at 450°F. and the residue weighed.

By this method the error is reduced so that accurate determination of all non-volatile material including noble and base metals can be made in parts per ten million. (A. C. S. specifications call for analyses of samples weighing 20 grams permitting accurate determination no greater than parts per hundred thousand.)

Spectrographic Analysis—A 3-gram sample of mercury is dissolved in nitric acid, evaporated to dryness. The residue is thoroughly mixed with graphite and the emission spectrum determined with a Bausch and Lomb 1.8 meter spectrograph, utilizing an Eastman Kodak SA-2 plate. The 3281 Å line of silver is measured with a photoelectric densitometer. The reading is correlated to concentration through a previously established calibration chart.

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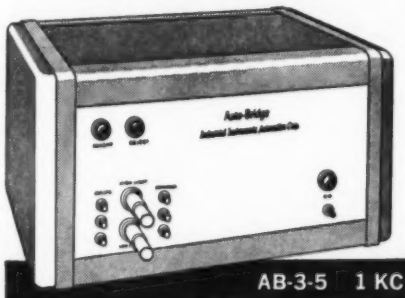
NEW! AUTOMATIC SEMI-AUTOMATIC MANUAL

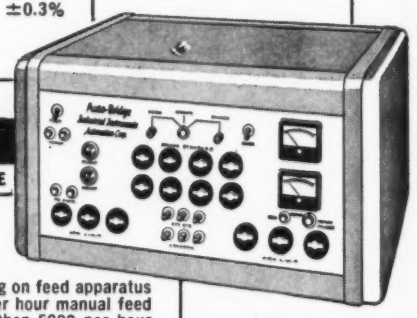
PRODUCTION TEST EQUIPMENT



THREE NEW INSTRUMENTS in matching enclosures for testing at the three most commonly used frequencies...DC, 1 KC and 1 MC. Available in three versions, automatic, semi-automatic and inexpensive manual units with no operator decision required.

AB-3-5 1 KC LIMIT BRIDGE

	RANGE	ACCURACY	PROD. RATE
Capacity	100 uuf to 15 uf lower at reduced accuracy.	±0.3%	Depending on feed apparatus —1500 per hour manual feed to more than 5000 per hour with automatic feed.
Resistance	10 ohms to 5 megohms, higher at reduced accuracy.	±0.3%	
Impedance	10 ohms to 5 megohms, higher at reduced accuracy.	±0.3%	

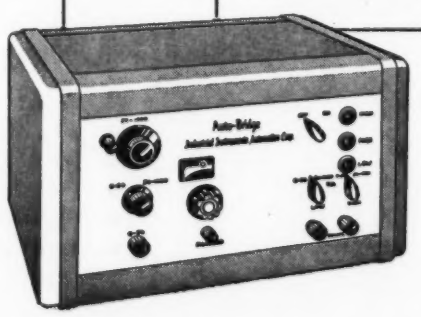


MODEL AB-4-4 DC LIMIT BRIDGE

	RANGE	ACCURACY	PROD. RATE
Resistance	10 ohms to 100 ohms.	±0.3%	Depending on feed apparatus —1500 per hour manual feed to more than 5000 per hour with automatic feed.
	100 ohms to 5 megohms.	±0.1%	
	5 megohms to 10 megohms	±0.2%	

AB-5-1 1 MC LIMIT BRIDGE*

	RANGE	ACCURACY	PROD. RATE
Capacity	0–1000 uuf in two ranges. (+ tolerance 0 – 100% – tolerance 0–25%)	±½% from 0–500 mmf ±1% to 1000 mmf	Depending on feed apparatus —1500 per hour manual feed to more than 5000 per hour with automatic feed



*Can also be used for continuous measurement

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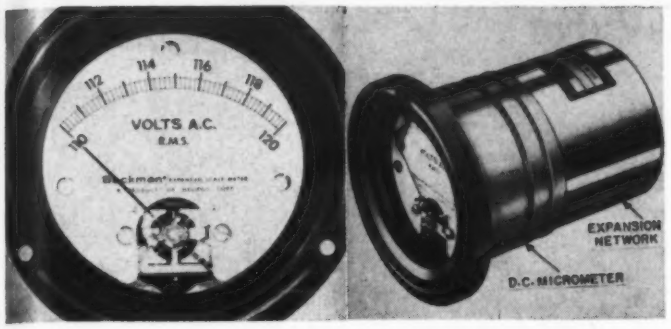

FIG. 1. EXPANDED SCALE Voltmeter, consisting of dc microammeter combined with built-in expansion network bridge, provides high accuracy with field-type ruggedness in new control and support equipment metering applications.

PRECISE VOLTAGE MONITORING WITH EXPANDED SCALE METERS

BOB CARTER, Beckman Instruments, Inc. Helipot Div.

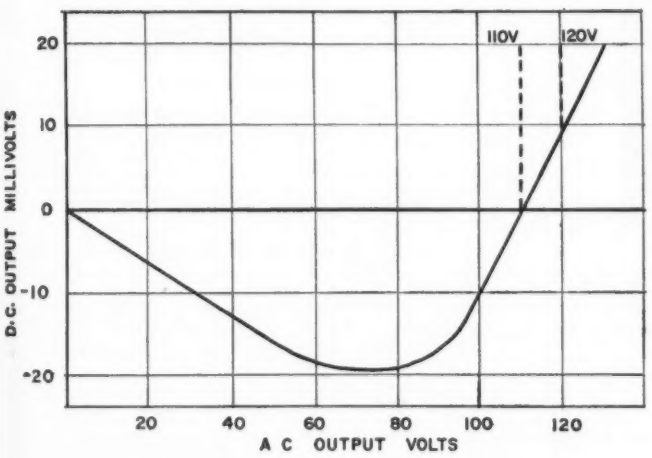

FIG. 2. PHASE-SENSITIVE Demodulator Output is linear over the significant range of operations.

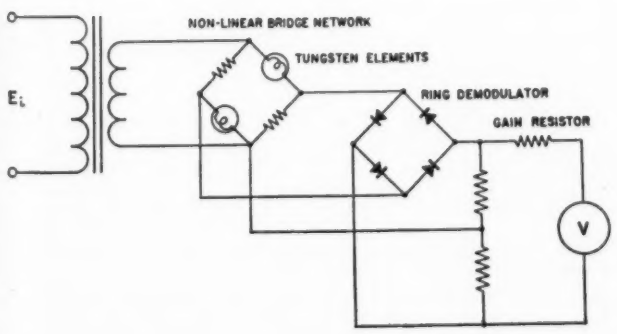

FIG. 3. EXPANSION BRIDGE Network has two resistors selected to equal the thermal elements at the input voltage corresponding to the left end of the scale. At this voltage the bridge is symmetrical and no current flows through the microammeter. Input voltage rise unbalances the bridge and drives the microammeter. A phase-sensitive demodulator is incorporated in the microammeter to detect the direction of unbalance (above or below null).

MONITORING AC POWER supplied for increasingly complicated electronic and support equipment has become too exacting a job for most conventional panel-mounted instruments and in some cases, even the laboratory standard. The expanded scale ac voltmeter, such as those presently produced by the Helipot Div., Beckman Instruments, is an effective answer to measurements where accuracy over a limited voltage range is essential. The expanded scale meter provides all the ruggedness and environmental capabilities of the conventional meter, plus accuracies as high as 0.3% (Fig. 1).

This instrument consists of a standard dc microammeter and a stable, nonlinear bridge which is balanced at the voltage corresponding to the left end of the scale. For example, in an expanded scale voltmeter with a range of 110 to 120 volts the bridge is balanced at 110 volts. Any increase in applied voltage results in bridge unbalance which is applied to the microammeter until at 120 volts the meter is driven to full scale deflection. Voltages below the balance point also result in bridge unbalance, so that the polarity at the microammeter is reversed, which holds its pointer against the left hand stop (Fig. 2).

The high accuracies obtained in this technique are the result of transposing the error of a low range instrument to a percentage based on a much higher value, plus some small allowance for the nonlinearity of the bridge. In the example above the microammeter covers a range of from 0 at 110 volts to full scale at 120 volts. Therefore, its basic range can be considered to be 0-10 volts. In a standard 2% instrument the error in a 10 volt scale is 0.2 volts. With an additional 1% allowed for bridge nonlinearity, the total error is 0.3 volts. Expressed as a percentage of 115 volts, this is a little less than 0.3% error. It follows that a wider scale range will result in a corresponding decrease in accuracy. Thus, a range from 105-125 volts (20 volts) will provide an accuracy of ±0.6 volts, or approximately 0.6%.

Of almost equal importance is the resolution, or readability, of the Expanded Scale Voltmeter which is increased by the same factor as the accuracy. This allows quick, sure readings taking full advantage of the instrument's accuracy. Also, mirrored scales—or similar complications—are not required.

Two types of expansion networks are employed in these instruments. One is essentially true rms sensing (Fig. 3), the other is average sensing. Both offer the same basic advantages, although the rms sensing unit is generally preferred because of the severe effect which distortion of the input waveform can have on the output of the average-sensing device. These distortion effects are almost impossible to anticipate because of the complex relationship between a given amount of distortion and resultant waveform. It is not unusual for 5% distortion to affect the indication of an average-sensing type instrument by 2%. Average-sensing instruments do offer the advantage of lower power consumption; nominally one watt instead of two, and so are preferred when wave form distortion is not a factor.

Because expanded scale voltmeters vary in impedance across the scale, multiplying resistors are not used with this type of meter. Instead they are furnished in multiple range types for applications where more than one voltage is to be monitored. This is generally done by tapping the input transformer. Where the expansions (in percentage) are unequal, the bridge output varies between ranges, requiring that separate current limiting resistors for each range be provided in series with the microammeter, and complicating switching somewhat.

Direct current versions of the expanded scale voltmeter, which provide the same high accuracy and readability as the ac instruments, also are available.

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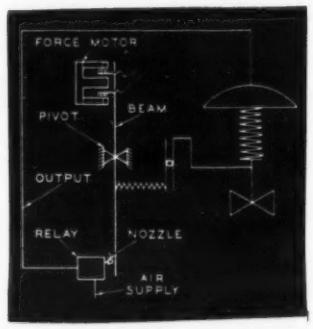
Electropneumatic Valve Positioner

Accuracy and responsiveness of pneumatic valve positioning is facilitated by a new force-balance electro-pneumatic positioner, designated the Masoneilan Model 8010. This device provides an accurate means of obtaining a valve plug position directly proportional to a low power dc input signal. It also provides a convenient and accurate method of split-ranging controller output signal for sequential operation of two or three control valves by a single controller. It is available for either direct action (increase in electrical signal increases output pressure) or reverse action (increase in electrical signal decreases output pressure) on direct (air-to-push-down) or reverse (air-to-push-up) actuators.



The new system is said to combine the desirable characteristics of electronic control with the power and smooth throttling action of pneumatic valve control.

Operation

With direct action an increase in the output signal of an electronic controller causes the coil to produce a force on the beam (see diagram), moving the flapper to cover the nozzle. The increase in nozzle back pressure causes the relay plug to close the exhaust seat in the diaphragm block and open the inlet seat, increasing positioner output pressure to the control valve actuator. The resultant valve stem motion is transmitted through the take-off linkage and positioner levers to the force balance spring, extending the spring until the force exerted by it on the beam balances the opposing force of the coil. As these two forces tend to equalize, nozzle back pressure decreases, allowing the relay plug to close the inlet seat and open the exhaust seat. The system then is in equilibrium and positioner output is stabilized at an amount necessary to maintain the desired valve plug position.

When the forces on the beam are in equilibrium, there is theoretically no flow of air into or out from the relay. Actually, a small bleed is provided between supply and output to increase relay responsiveness when at equilibrium.

Reverse action (increase in electrical signal decreases output pressure) is obtained by reversing the input signal leads and rezeroing the positioner.

The basic electrical circuit of the positioner has a nominal resistance of 2600 ohms designed to receive a 1 to 5 ma dc input signal. However, this circuit is also available in other values to accommodate the dc

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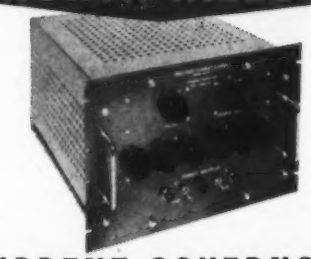

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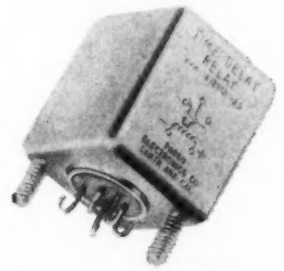

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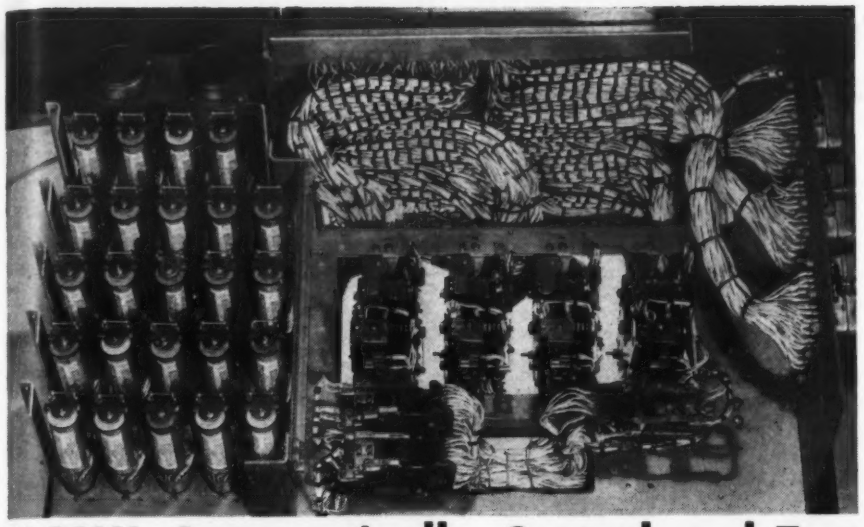

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These capabilities make it possible to achieve extremely high standards with complex relay chassis and similar systems, thus eliminating borderline errors which can lead to malfunction under operating conditions.

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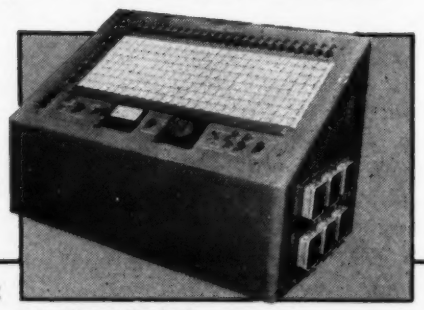

SPECIFICATIONS:

1. Continuity Test
   - A. Test Voltage ..... 28 V.D.C.
   - B. Continuity Current ..... 1 ampere
   - C. Continuity Resistance ..... adjustable from 0.3 ohms to 10 ohms
2. Continuity-Discontinuity Test
   - A. Test Voltage ..... 28 V.D.C.
   - B. Continuity Current ..... 1 ampere
   - C. Continuity Resistance..0.3 ohms to 10 ohms
   - D. Discontinuity Resistance ..... 2.5 megohms reject, 3 megohms accept
3. Short Test
   - A. Test Voltage ..... 28 V.D.C.
   - B. Test Current ..... 0.03 ma (max)
   - C. Short Resistance Range ..... 2.5 megohms reject, 3 megohms accept
4. Ohmmeter
   - A. Range ..... 0 to 200 megohms
   - B. Accuracy ..... ±3%
5. Timer (Standard)
   - A. 60 minute range, 0.2 second scale division
   - B. Accuracy..0.1 sec. per operation at 60 cycles

   Timer (Optional)
   - A. 60 minute range, 0.01 second scale division
   - B. Accuracy..0.002% per operation ±1 division
6. Power Requirements
   - A. 100 to 125 V.A.C. 55 to 65 cycles (standard timer)
   - B. 100 to 125 V.A.C. 50 to 400 cycles (optional timer)
7. External Energization
   - A. 28 V.D.C. and 110 V.A.C., 60 cycles are provided for external energization of relays or other resistive devices, isolated from test voltage.
   - B. Other voltages may be supplied by external power supplies and switched as external energization or other test purposes.

CIRCLE 34 ON READER-SERVICE CARD

input of nearly all the electronic controllers presently on the market. Typical circuits available include:

Input Current dc Signal	Load Requirement of Controller	M–N Transducer Input Resistance
1–5 ma dc	3,000 ohms (max)	2,600 ohms (nominal)
1–5 ma dc	12,000 ohms	12,000 ohms
10–50 ma dc	600 ohms	*500 ohms

*Controller manufacturing specifications may require addition of a resistance so that the total load requirement of controller (i.e. 600 ohms) includes line resistance.

Performance

Speed of the positioner with integral relay and at a normal 20 psi supply pressure, varies with the actuator size and valve stroke, as shown in the table below:

ACTUATOR SIZE	VALVE STROKE (inches)	SPEED (seconds)
9	½	1.5
	¾	1.8
11	¾	2.8
	1	3.3
13	1	4.9
	1½	6.3
15	1½	9.4
	2	11.4
18	2½	21
	3½	29
	4	32

From 4-page catalog Section 305-14, *Mason-Neilan Div., Worthington Corporation,* 51 *Nahatan St., Norwood, Mass.*)

FOR THIS LITERATURE CIRCLE 103 ON READER-SERVICE CARD

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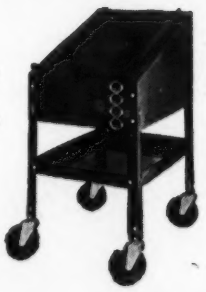

- ★ Sturdy steel, gray baked-enamel finish, meets military specifications
- ★ 5" ball-bearing rubber tired casters
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Accommodates any standard scope by easy bracket relocations. From 6" to 12¾" wide; from 16½" to 22½" long.

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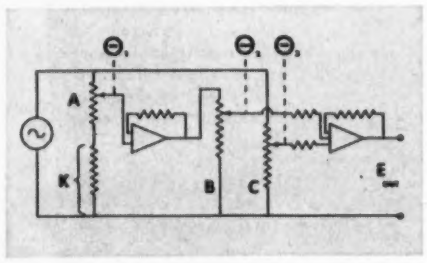
CIRCLE 36 ON READER-SERVICE CARD

DESIGN IDEAS FOR ELECTRONIC ENGINEERS:

How to design better analog computing circuits with Vernistat* a. c. potentiometers

Analog computers typically use such components as potentiometers, resolvers, and linear synchros to relate shaft position to voltage. In most applications, to reduce the effect of loading error, high impedance circuits, and phase shift, a substantial amount of additional equipment, such as isolation amplifiers and auxiliary power supplies, is required. Size, weight, heat dissipation, and possibility of failure are thus greater than if loading error, phase shift, and high output impedance problems did not exist.

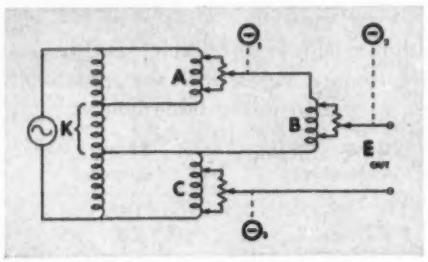
Typical of a class of equations which are incorporated into much analog computer circuitry is the relation $E_{out} = [K + A(\Theta_1)]\, B(\Theta_2) + C(\Theta_3)$.



ONE WAY TO SOLVE this relation is shown in this diagram of a conventional resistance potentiometer computing circuit. Such circuits, however, suffer from excessive phase shift, particularly at high frequencies.

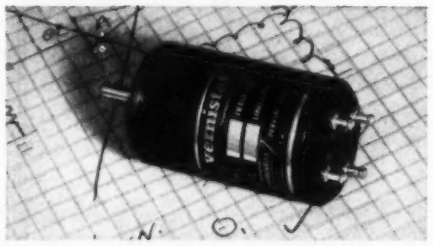
Due to high potentiometer output impedances, the circuit requires an isolation amplifier in the multiplying channel, while summing resistors and a feedback amplifier are required in the addition section. Both of these amplifiers, as additional components, add a factor of unreliability and use more power, increasing the problem of heat dissipation.

A MORE EFFICIENT WAY TO SOLVE this equation is with Vernistat a.c. Potentiometers. The Vernistat is an ideal component for analog computer systems. Its combination of a tapped autotransformer and an interpolating potentiometer uniquely provide characteristics unobtainable with other types of shaft position-voltage devices. The Vernistat provides precise voltage division, high input impedance, low output impedance, and low phase shift. These characteristics directly relate to the design of improved computer circuits.



FOR EXAMPLE, in the computer circuit shown here, multiplication may be performed without the aid of an isolation amplifier, because of the Vernistat's high ratio of input to output impedance. Addition is accomplished by utilizing voltages of opposite phase in the two computing channels obtained by a tapped input transformer. By eliminating the amplifiers of the preceding circuit, a reduction of size, weight, heat rise, and power requirements is obtained. With fewer components required, there is an over-all increase in reliability.

IN SOLVING DESIGN PROBLEMS like these, Vernistat a.c. Potentiometers offer such major advantages as: low output impedance (as low as 40 ohms) with high input impedance (as high as 200,000 ohms)—high resolution (to 0.002%)—low phase shift (as low as 0.2 minutes)—and high terminal linearity (to 0.01%). Vernistats meet the requirements of MIL E 005272-B, and operate at 125°C without derating.



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CIRCLE 37 ON READER-SERVICE CARD

Simplicity is Virtue of Cobra Missile

True simplicity is a rare attribute of modern missiles in any size or type. However, a guided missile now secheduled for early evaluation by the Marine Corps as a Gyrene-transported and operated anti-tank weapons system can not only claim simplicity but is unique in other ways.

FIG. 1. "COBRA" Anti-Tank Missile is guided from small box on knee of Marine.

A contract for 100 of the new missiles, designated The Weapons System 810 Anti-tank Missile, has been placed with Daystrom, Incorporated, Murray Hill, N. J., for evaluation by the Marine Corps. Although these will be manufactured by Boelkow Eltwicklungen K. G. of Munich, West Germany, Daystrom plans eventually to produce them at its plant in Archbald, Pa.

Weighing only 28 lbs packed in its styrene foam case, the 20.2 lb missile requires no launching ramp and utilizes a guidance control box weighing only 4.4 lbs. It attains a velocity of 191 mph and can achieve a kill in excess of 1 mile range, penetrating up to 21" armor with a shaped-charge warhead. Two of the missiles can be handled readily by a single Marine and both can be readied for firing in about three minutes preparation (Fig. 1). Up to eight missiles can be connected to a single controller for firing in sequence.

Guidance depends on 28v dc electrical impulses transmitted to the guidance mechanism of the missile over a fine, silk-wrapped 2-wire line. These impulses control the vibration of four spoiler vanes on the missile tail, enabling the Marine to guide it up, down, right or left. He can control the COBRA from a position up to 100 yards from its launching spot by means of a cable reel extension. Another innovation is the stabilizing gyro which is brought up to 12,000 rpm speed by a stout cord, anchored to the ground at the launching point. This procedure, similar to that used to spin a toy gyroscope, indicates the simplicity employed in the system to make it inexpensive, light, and easily maintained. The gyro provides a guidence reference in that it roll-stabilizes the missile while in flight. The control box uses a short "joystick" which is pushed forward for nose down, back for nose up, right and left

Resistance up to 100 Million (1×10^{14}) MEGOHMS !

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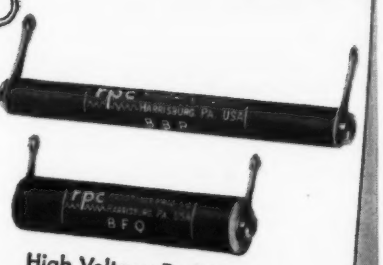

High Voltage Resistors

From a miniature ¼ watt resistor, rated at 250 volts, to the 100 watt resistor, rated up to 125 KV. Tapped resistors and matched pairs also available. Low temperature and voltage coefficients.

Few can match—and none can exceed—the stability and performance of rpc HIGH VOLTAGE RESISTORS! Ask anybody who uses them.

Tolerance—15% standard. 10%, 5% and 3% available. 2% in matched pairs.

Further information or engineering assistance gladly supplied.

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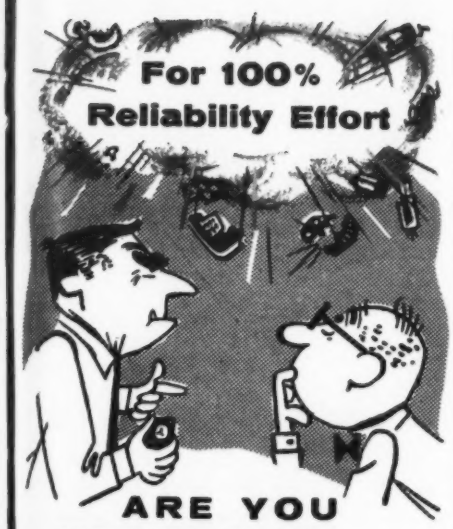

ARE YOU MEASURING . . .

- Actual life span of your equipment?
- Consumption of rated life of critical equipment or components?
- Mean-time-to failure?

You can reduce the odds against failure by constant monitoring and timely replacement of equipment approaching the end of assured performance . . . by thoughtful application of the . . .

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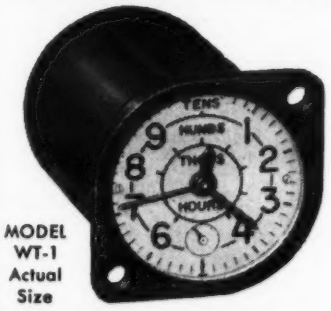

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10,000 Hour Total Readout (Easily Read to Closest Hour) 400 CPS

Whether it's for reliability and life testing, design or system analysis, utilization studies . . . or to continuously monitor and log critical equipment or components . . . when you incorporate the Waltham WT-1 in your plans, you add that "measure of reliability" so important for military acceptance.

The WT-1 meets MIL-E-5272A and is available "FROM STOCK" Write Now for Bulletin 5001!

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Waltham 54, Massachusetts

CIRCLE 39 ON READER-SERVICE CARD

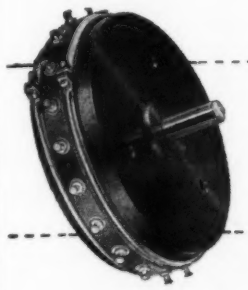
by operator who must simultaneously observe his target and the missile while it is in flight.

The evaluation contract includes not only the cost of the 100 missiles and auxiliary equipment but also an electronic trainer-simulator which enables the Marine missileman to develop the skill necessary to guide the

FIG. 2. ELECTRONIC Trainer exercises missilemen without expenditure of costly missiles.

missile without expending a large number of practice rounds. (Fig. 2). On the scope of this trainer a moving, programmed spot is guided toward a target circle by a "joystick" similar to that on the missile system control box. This spot resembles the flare on the rear of the missile.

FOR MORE INFORMATION ON DEFENSE ACTIVITIES OF DAYSTROM, INC., CIRCLE 104 ON READER-SERVICE CARD



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A precious metal ring is the heart of a Gamewell Style SG-270 Precision Rotary Switch.

This perfect circle of metal may be cut into as many angular segments or positions as desired . . . providing the precise basis for a highly versatile switching component . . . can be assembled with potentiometer sections if desired.

Custom designed, the SG-270 switch is ideal for circuit sampling, sequencing, programming, digital generators, etc. Connections to the segments are made through terminals adjacent to the segments on the periphery of the housing. Precious metal rings and brushes provide smooth, trouble-free action with either Make Before Break (MBB) or Break Before Make (BBM) contacts. Multiple gangs can be assembled to provide multi-pole switches. Cased in special plastic, the SG-270 switch is inherently fungus resistant . . . stable at high temperatures . . . sizes 5/8" — 1 1/4" — 1 5/8" — 2" — 3" — 5" diameter in various mounting styles. It can be used with confidence over a wide range of environmental requirements. Write, stating requirements, to THE GAMEWELL COMPANY, 1526 Chestnut Street, Newton Upper Falls 64, Massachusetts.

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"Integrals of High Performance"

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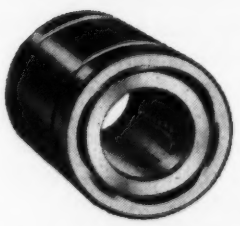
...*for* **MINIATURIZATION**

NEW! miniature BALL BUSHINGS for LINEAR MOTIONS



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Analysis Problems

Vibration • Distortion • Pulses • Noise

Probescope Sonic and Ultrasonic analyzers all have automatic optimum resolution circuitry. Guesswork has been taken out of spectrum analysis. One control sets the proper bandwidth and sweepwidth to give the best possible resolution... other features include... 60 db dynamic range... linear and log amplitude scales... internal calibration markers.

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Frequency Range	7 cps to 23 kc
Sweep Width	50 cps to 6 kc
Sensitivity	500 microvolts
Resolution	14 cps

SPECIFICATIONS	SS-100
Frequency Range	13.5 cps to 110 kc
Sweep Width	200 cps to 20 kc
Sensitivity	500 microvolts
Resolution	27 cps

SPECIFICATIONS	SS-500
Frequency Range	75 cps to 600 kc
Sweep Width	2 kc to 200 kc
Sensitivity	250 microvolts
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All Probescope analyzers feature 100 db dynamic range sweep generator attachments to visually display passband characteristics of amplifiers and filters. Noise and distortion which normally obscures response curves are eliminated.

Other spectrum analyzer models for subsonic, single sideband and telemetering analysis.

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CIRCLE 42 ON READER-SERVICE CARD

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Design of Miniature High-apa

IN THE SEARCH for ever smaller and lighter capacitors with high reliability, high capacitance ratings and rugged mechanical strength, the high specific inductive capacity of ceramic dielectrics attracted much early attention. The dielectric constant of paper and film materials is only 4 to 5 while good ceramic dielectrics can be formulated with constants of 1200 to 6000.

However, any benefits of the high dielectric constants of ceramics have been offset to a considerable degree because of other limiting physical properties such as poor formability and inherent brittleness which required the use of relatively think dielectric bases. Special processes have resulted in the reduction of dielectric blanks down to about 5 or 6 mils which can be processed by conventional methods into finished capacitors. Although thinner ceramic sheets can be produced, their fragility is such as to make further processing impractical.

The research department of the HI-Q Division, Aerovox Corpration, of Olean, N. Y., headed by Dr. A. R. Rodriguez decided that only unorthodox methods of design and construction could accomplish further reductions in size and weight of ceramic capacitors. As the result of this research, two separate methods have been evolved for the production of ceramic capacitors of high capacity per unit volume.

Cerafil Type Construction

The first method was to reduce the thickness of the dielectric film by forming it in place over the first metallic plate. The Cerafil* (Ceramic film) method employs a thin ceramic rod or filament approximately 1/32" in diameter, which first receives a metallic film coating. The film is next coated with a very thin film of ceramic slip, which is then fired. The outer surface of this ceramic film is next given a second metallic coat, to form the second electrode. The length of this basic unit can be varied for greater or less capacity, but higher values are formed by connecting bundles of these capacitor elements in parallel. The bundled Cerafil rods form a cylindrically shaped honeycomb structure, the surface-to-volume ratio of which increases with diminishing rod diameters. A plastic coating protects the as-

High-Capacity Ceramic Capacitors

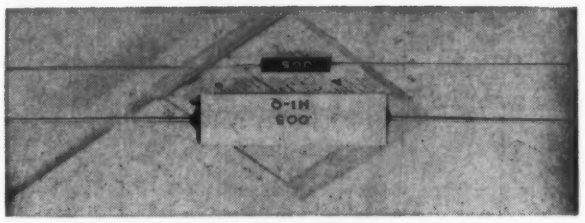


FIG. 1. CERAFIL CAPACITOR (in black) is shown in actual size and compared with equivalent capacity conventional ceramic capacitor. In capacities from 10 micromicrofarads to 0.1 microfarad, this construction is said to be the most compact known.

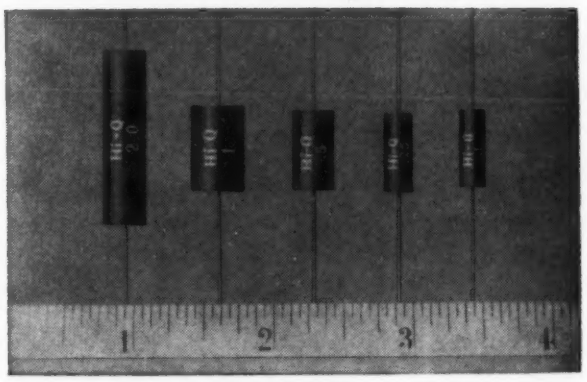


FIG. 2. CEROL CAPACITOR construction methods extend high-capacity-per-unit-volume to 2 microfarad size. These capacitors are rated at 100 v dc up to 85°C and to 50 v dc up to 125°C.

sembly and adds mechanical strength to the unit (Fig. 1).

The construction of cylindrical metal and ceramic films around a solid ceramic core gives great mechanical strength, particularly when a number of units are bundled to obtain higher capacities.

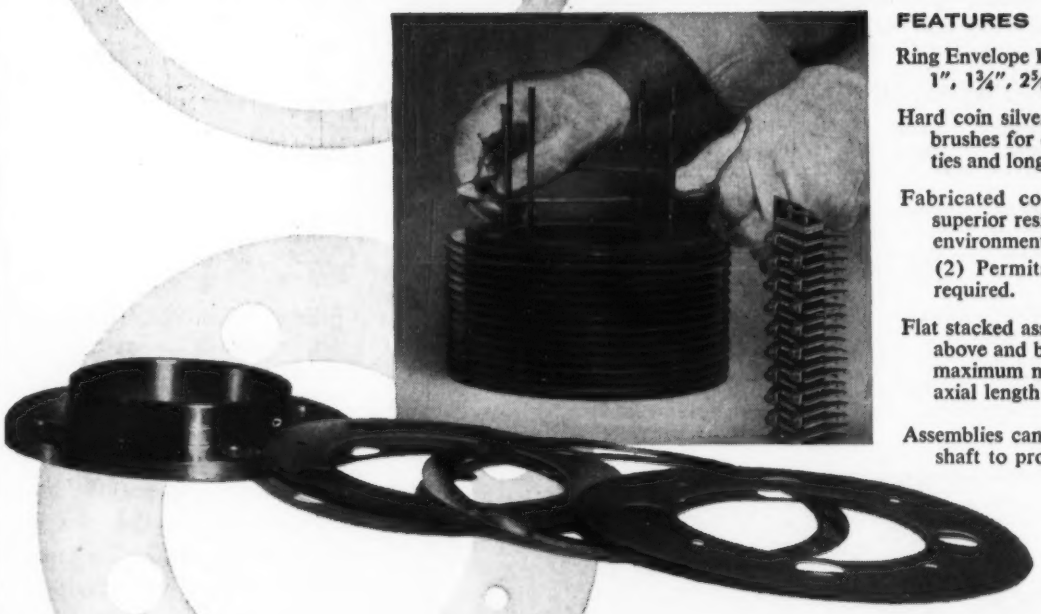
Each Cerafil unit is individually tested before assembly to assure great reliability for the composite capacitor, also, by combining units having positive temperature coefficients with other units with negative TC's, a capacitor having a flat capacity-temperature characteristic can be produced.

Standard Cerafil capacitors range in size from 0.090" diameter x 0.320" long for the 0.001 μf unit to 0.310" diameter x 0.750" long for the 0.1 μf unit. These units are rated at 100 v dc with a maximum power factor of 2.5% at 1 kc and a variation of ca-

AN ANALYSIS covering over four thousand custom slip ring assemblies designed and produced by Breeze Corporation during the past seventeen years has shown that a substantial number of these requirements have been for assemblies having similar size and operating characteristics.

Now . . to meet these repetitive requirements more rapidly and at reduced costs, Breeze offers seven standard size slip rings with ring envelope diameters from 1" through 10½".

SEVEN STANDARD SLIP RING SIZES NOW in stock!



FEATURES

Ring Envelope Diameters:
1", 1¾", 2⅜", 4⅞", 9⅜", 10½".

Hard coin silver rings and silver graphite brushes for excellent electrical properties and long life.

Fabricated construction (1) Provides superior resistance to shock, vibration, environmental conditions.

(2) Permits addition of rings when required.

Flat stacked assembly with rings mounted above and below each barrier provides maximum number of rings in shortest axial length for rated capacities.

Assemblies can be stacked on a common shaft to produce a multiple unit.

You'll want a copy of the new Breeze catalog 66 SR which contains complete details on these standard units. Catalog 66 SR also describes a wide range of custom units and incorporates a design guide section. Write for your copy today.

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CIRCLE 44 ON READER-SERVICE CARD

Engineering notes from the

SMI REPORTER

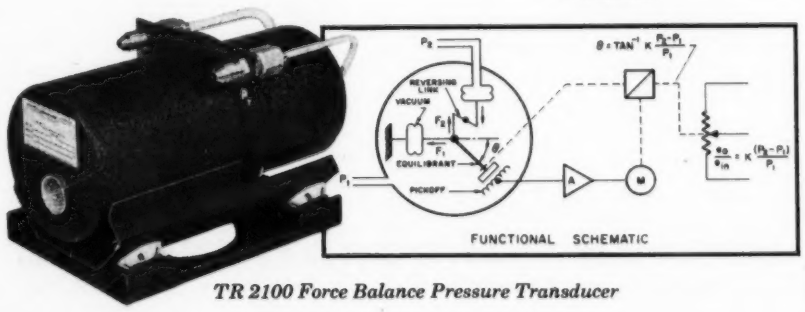
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 3
TR 2100 Force Balance Pressure Transducer

SMI is now producing a new, unusually flexible Force Balance Pressure Transducer that features both electrical and mechanical output capabilities. Extreme sensitivity and accuracy is combined with unique flexibility in the TR 2100. It is available in ten models and the functional "Mechatronics" packaging philosophy permits prompt delivery of standard transducers covering a wide range of applications: from subsonic to supersonic aircraft, drones and missiles, to ground support, and test equipment. The functional schematic, shown below, illustrates the basic force balance principle. The transducer measures 3¾" dia. x 7" long, weighs 3.25 lbs., without shockmount, and conforms to MIL-E 5400 and 5272.

Typical Performance Specifications

Type No.	Inputs Physical	Computation	Output Range	Output Form	Accuracy	Threshold
TR 2100	Total & Static Pressure	Mach No.	$0.1 \leq M \leq 1.0$ $-1000 \leq$ Alt. $\leq 100{,}000$ ft.	Pot. or Synchro	± 0.001 M	0.0001 M
TR 2100-2	Total & Static Pressure	Mach No.	$0.12 \leq M \leq 3.0$ $-1000 \leq$ Alt. $\leq 100{,}000$ ft.	Pot. or Synchro	$0.003 \leq M \leq 0.015$	0.0002 M
TR 2100-5	Static Pressure	Altitude Deviation	± 500 ft. From -1000 to $+80{,}000$ ft.	Pot. or Synchro	—	2 ft.
TR 2100-6	Static Pressure	Pressure Altitude	-1000 to $+100{,}000$ ft.	Dual Speed Synchro	$\pm$ (25 ft. + 0.25%) -1000 to 5000 ft. $\pm$ (40 ft. + 0.25%) 5000 to 80,000 ft. $\pm$ 0.5% to 100,000 ft.	2 ft. to 40,000 ft.
TR 2100-7	Turbine Outlet (P_7) And Compressor Inlet (P_2) Pressures	Engine Pressure Ratio (E.P.R.)	$1 \leq$ E.P.R. ≤ 4	Pot. or Synchro	7 in. $\leq P_2 \leq$ 30 in. $1.9 \leq$ E.P.R. ≤ 2.6 ± 0.010 E.P.R. 3 in. $\leq P_2 \leq$ 40 in. $1.0 \leq$ E.P.R. ≤ 4.0 ± 0.020 E.P.R.	0.0005 E.P.R.



TR 2100 Force Balance Pressure Transducer

For more information and complete operating specifications on the TR 2100 Force Balance Pressure Transducer, write or wire today. Address your inquiries to Stanley M. Ingersoll, Capabilities Engineer.

SERVOMECHANISMS, INC.
Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

CIRCLE 45 ON READER-SERVICE CARD

pacity of approximately +10% to −15% over the range of −55°C to 85°C, based on 25°C as reference temperature. All applicable requirements of MIL-C-11015B are met by Cerafil Capacitors.

Cerol Capacitors

For capacities higher than 0.1 μf the Cerafil construction becomes less efficient, and another method of construction was evolved.

The most desirable characteristic of paper and plastic film dielectrics is their ability to be rolled into a compact bundle, thus providing a large capacity in a small space. In similar manner, a flexible ceramic sheet which first can be given a metal coating, rolled into a cylinder, then fired into a compact

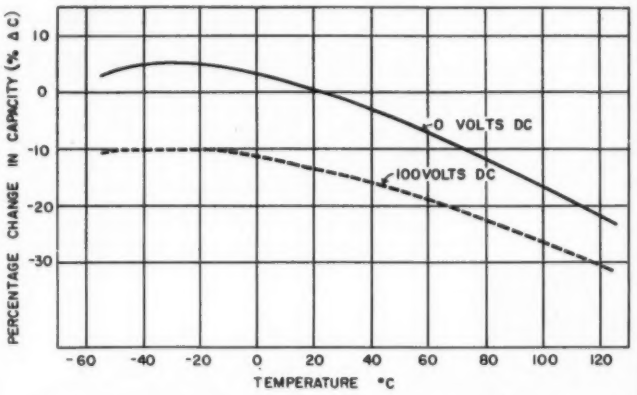


FIG. 3. TEMPERATURE CHARACTERISTIC for typical Cerol Capacitor Type CL 90. Various temperature characteristics can be achieved through control of the ceramic formulation.

monolithic structure of high strength is now being marketed under the descriptive name of Cerol* (Rolled Ceramic). The new method, presently in limited production, produces units from 0.1 to 2.0 μf. A 2 μf unit is only 0.4" diameter by 1.4" long, is rated at 100 v dc at temperatures from −55°C to 85°C and at 50 v up to 125°C. Power factor is 2.0% max at 1 kc, and capacitance variation is +15% −25% over the −55°C to 125°C range (Fig. 3). All the applicable requirements of MIL-E-11015C are met or surpassed by Cerol capacitors.

Cerol capacitors are designed for general purpose uses in bypass-couplings, filtering and blocking circuits. They have superior electrical characteristics for decoupling and pulse circuits where low series resistance at high frequencies combined with extremely miniature sizes are necessary. Digital computers are typical of such critical applications.

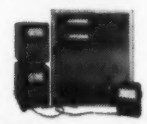
In comparison with tantalum or other electrolytic type capacitors, the Cerol capacitors are non-polar and have much higher insulation resistances. Leakage is not a factor in design when Cerol capacitors are used.

The Cerol technique can be applied using various

the industry's pioneer & complete line of

MINIATURIZED ELECTRONIC INSTRUMENTS

CUSTOMIZE EFFICIENCY & ACCURACY WITH TRIO LABS' BUILD-IN INSTRUMENTS



BEFORE . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.

AFTER . . . 3 trio labs' miniature VTVMs integrally built-in now are always on hand to measure just the parameters you designate.

By *building-in* trio labs' panel-mounting instruments you . . . customize test systems, set-ups and instruments; save space (average model is 4" x 4" x 4"); save time with at-a-glance monitoring; save money; make monitoring foolproof (go-no go"); improve system reliability; increase overall design freedom. Choose from many "standard" or "special" models—or consult us for new designs for your needs. Write for free "how to" Engineering Guide to Dept. **MSD-2.**

MILITARY for MIL-E-5400A & MIL-T-945A applications.

COMMERCIAL

B Series—ruggedized single-range, AC VTVMs $160.

E Series Single-range AC VTVMs $99.50

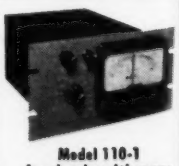
D Series—ruggedized multi-range AC VTVMs $272.

Model 109-1 low-level multi-range AC VTVM $199.

G Series—ruggedized single or multi-range DC VTVMs $136.

F Series single-range DC VTVMs $84.50

J Series—ruggedized low-level multi-range DC VTVMs $450.



Model 110-1 low-level multi-range DC VTVM $285.

trio®

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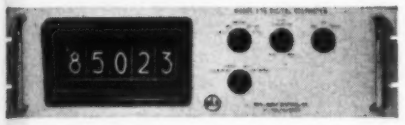
CIRCLE 46 ON READER-SERVICE CARD

NEED MORE THAN FOUR?

Only Voltmeter with the Factual Fifth Figure



WHEN FOUR-DIGIT ACCURACY JUST ISN'T ENOUGH, specify the five-digit NLS V35 — world's most accurate digital voltmeter. Only the V35 gives you the "factual fifth figure" . . . full five-digit resolution of 0.001%. Here is the instrument for your measuring jobs demanding maximum accuracy — automatic missile checkout, readout and printout in data logging and computer systems, critical production inspection. Only the V35 offers you the benefits of "no-needless-nines" logic — greater reliability, increased speed, longer parts life. Contact NLS today for the full story.

V35 Specifications: Measures DC voltage from ±0.0001 to ±999.99; DC voltage ratio from ±00.001% to ±99.999% . . . DC voltage accuracy is ±0.01% of reading or ±1 digit . . . overall accuracy for voltage ratio is ±0.005% of reading or ±1 digit . . . "factual fifth figure" — 0.001% resolution . . . transistorized "no-needless-nines" logic . . . plug-in modular construction . . . simple external connections for AC/DC converter, pre-amplifier and data logging accessories . . . one-package design — 5¼" high — for standard rack mount . . . automatic selection and indication of range and polarity . . . interchangeable plug-in stepping switch-resistor assemblies sealed in oil . . . $3,750.00, complete. Available in four-digit model for $3,150.00, complete.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (SAN DIEGO), CALIFORNIA

NLS — The Digital Voltmeter That Works . . . And Works . . . And Works!

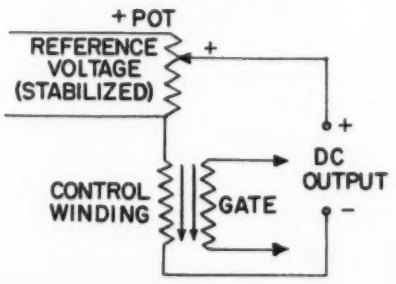
CIRCLE 47 ON READER-SERVICE CARD

ceramic formulations to achieve controlled temperature coefficients, which are not available other than in ceramic capacitors. An NPO (zero temperature coefficient) Cerol capacitor will assume a size of approximately 0.2" diameter x 0.650" long for a capacity of 2500$\mu\mu$f. At present, the highest capacitance available in temperature compensating capacitors is only a few hundred micro-micro-farads.

The new Cerol technique, therefore, opens up new avenues of design in temperature-compensated circuitry. A volumetric efficiency of 15 μf per cubic inch is now attainable with a ceramic having a temperature capacity stability of 20% from —55°C to 85°C, and up to 45 μf per cubic inch in a material having a stability of 60%. Also available in the near future will be Cerol capacitors with a 3-fold increase in volumetric efficiency for transistor applications below 100 v dc working voltage.

FOR MORE INFORMATION CIRCLE 105 ON READER-SERVICE CARD

Magnetic Regulation Guards D-C Supplies



MAGNETIC AMPLIFIER Uses saturable reactor principle to give stepless control of gate winding reactance, limiting input to static rectifying elements for output voltage regulation and diode overload protection.

New Dc Regulated Static Power Supplies with output ratings from 1 to 45 kilowatts power in the 28 v dc range are equipped with magnetic amplifier regulation to provide stable output under rapidly varying load conditions. Supplied with the customer's choice of selenium, germanium or silicon power diodes, magnetic control (See Figure) of the output voltage through saturable control reactors also provides overload protection by: (1) Limiting excessive current through each diode; (2) shutting down the unit within 3 cycles on short or overload; (3) protecting diodes against line ac transients and (4) protecting diodes against dc output bus faults or shorts.

Characteristics of Model 24322MA Supply, being used in military support applications, are typical: Output rating, 200 amp, 24-32 v dc; regulation ±½%; input 230 v, 3-ϕ, 60 cps; housing, all steel cubicle 48"H x 24"W x 21"D; rectifying elements, choice of silicon, germanium or selenium. (*From information in* 8-*page bulletin MA*-1 *Rapid Electric Co.,* 2881 *Middletown Rd., Bronx* 61, *N. Y.*)

FOR THIS LITERATURE CIRCLE 106 ON READER-SERVICE CARD

Engineering notes from the

SMI REPORTER

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 4

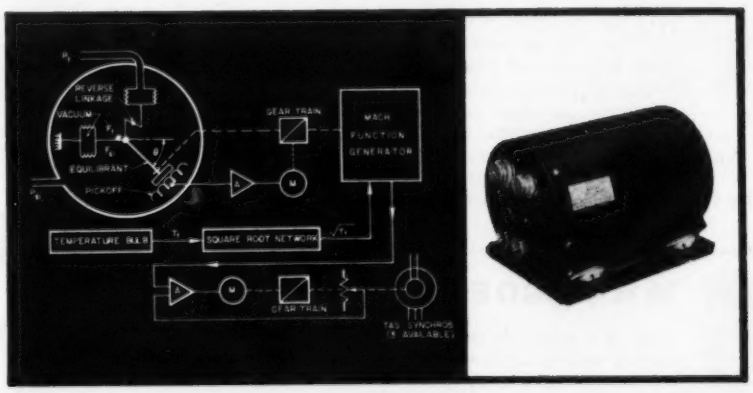
AXC 620 Miniature True Airspeed Computer (Minitas)

Exceptional accuracy and small size are key features of SMI's new Miniature True Airspeed Computer. Any one of three true air speed operating ranges and accuracies can be supplied to meet the requirements of high-performance aircraft, patrol planes, helicopters, artillery-directing aircraft, and missiles. The MINITAS consists of an extremely sensitive and accurate force balance Mach transducer, a passive resistance network, and a follow-up servo. The transducer is made up of a pressure ratio sensor — which is the heart of the system — a servo, and an electrical function generator. All servo amplifiers use silicon transistors for uniform reliability in severe environments. The MINITAS is capable of operation in a 125°C. environment and requires only 20 watts of 115 vac, 400 cps power. Without shockmounts, the computer measures 5" dia. x 8¼" and weighs 6.5 lbs. The MINITAS conforms to MIL-E-5400 and MIL-E-5272.

Typical Performance Specifications

TYPE NO.	TRUE AIRSPEED RANGE (KNOTS)	ALTITUDE (FT.)	ACCURACY (KNOTS)
AXC 620	70 — 450	0 — 20,000	
	70 — 125	0 — 20,000	± 4¾
	125 — 450	0 — 12,000	± 1¾
	125 — 450	12,000 — 20,000	± 2¾
AXC 620-1	100 — 200	0 — 10,000	± ¾
AXC 620-2	300 — 1500	0 — 80,000	± 12

NOTE: These are standard accuracies. Increased accuracies are available over restricted ranges upon request, and special ranges and output forms are also available. AXC 620 and AXC 620-1 are capable of operation up to 40,000 ft. with reduced accuracies.



FUNCTIONAL SCHEMATIC—AXC 620 Miniature True Airspeed Computer

For more information and complete operating specifications, write or wire SMI today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

SMI

SERVOMECHANISMS INC.

Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

CIRCLE 48 ON READER-SERVICE CARD

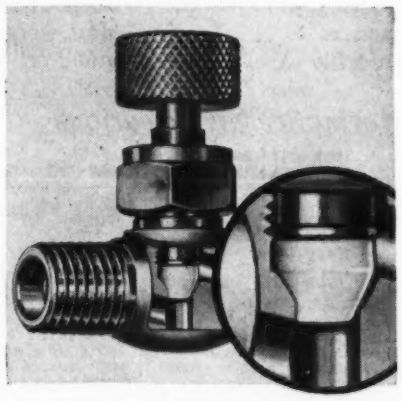
HOKE Flow Sheet

HOKE REPORTS ON FLUID CONTROL (1)

HOKE'S NEW PLASTIC STEM TIPS END CHRONIC FAILURE PROBLEM

Galling and scoring valve seats plagued valve users and manufacturers for years, until somebody thought of using plastic stem points. This idea worked well at low pressures, but when the pressure increased — poof! — the valve blew its tip. Up to now, this problem had continued to bother valve makers.

Fortunately, a die-hard Hoke engineer insisted he could put a permanent plastic tip on a high pressure valve. We gave him his head and he gave us a plastic-tipped valve-stem (using either Kel-F or Nylon). His unique design incorporates a crimped metal shell that grabs the plastic tip and *really* holds!



Not satisfied with this monumental accomplishment, he proceeded to tackle leak problems at the stem packing. He put an O-ring seal on the stem and compressed it with a newly-designed Nylon collar. The collar serves a dual role, for it also prevents grit and other foreign matter from chewing up the O-ring. Valves of this new design have performed successfully up to 3500 psi. Our die-hard engineer not only ended galling, but also seat leakage, stem leakage and wear problems — all at one swoop.

There's only one feature about this new development that worries us — since we do not expect replacements we may have designed ourselves right out of the valve business! We make these little dandies of either forged brass, bar stock or 316 Stainless, with ⅛" and ¼" male connections. Temperature limit is 400° F. For the complete story, write, wire, phone or we'll come see you.

WHAT GOES WITH WHAT?

This is a question engineers and chemists are constantly asking each other. Not that we want to do away with this healthy interplay at the water cooler, but we have put together a slide rule that answers all these questions. It lists 22 metals and materials and their degree of resistance to 247 corrosive agents.

Got yours? Write now while there are a few (thousand) left.

HOKE, INCORPORATED
13 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:
☐ Plastic Stem Tips ☐ FREE Corrosion Slide Rule ☐ Have a salesman call

NAME_____TITLE_____

COMPANY_____

ADDRESS_____

CITY_____STATE_____

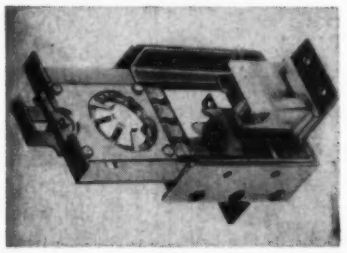
CIRCLE 49 ON READER-SERVICE CARD

MSD new products

MICROWAVE COMPONENTS

UHF TRIODE SOCKET

Model XV-100/6299 miniaturized planar tube socket designed for General Electric GL6299 UHF triode permits its use to over 1000 mc without

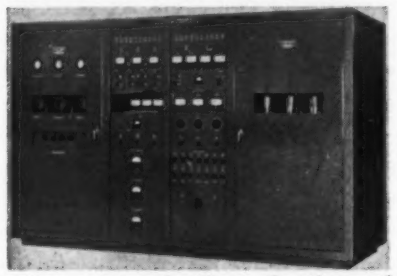


resonances over the band. Exceeds rigid environmental and Milspec requirements in circuits where frequency stability and low noise are essential.—*Instruments for Industry, Inc., 101 New South Rd., Hicksville, L. I., N. Y.*

CIRCLE 107 ON READER-SERVICE CARD

KLYSTRON POWER AMPLIFIERS

New 10 Kw Power Amplifier Model 216A, employing four-cavity, water-cooled klystron tubes, is designed for both military and industrial applications, including space programs and



scatter communications. Continuously tunable over the 1700-2400 mc range, it has a frequency bandwidth of 18 mc at half-power points. A companion amplifier, Model 217A rated at 1 Kw output is available for the same range.—*Sierra Electronic Corp., 3885 Bohannon Drive., Menlo Park, Calif.*

CIRCLE 108 ON READER-SERVICE CARD

LARGE LIGHTWEIGHT ANTENNAS

New HUBLOC antennas using new structural principles have high wind load rating, weigh only 1,575 lbs for 28-ft diameter, are assembled at location from prefabricated sections.—*Andrew Corporation, 363 East 75th St., Chicago 19, Ill.*

CIRCLE 109 ON READER-SERVICE CARD

TEMPERATURE and/or ALTITUDE CONDITIONS DURING SINUSOIDAL and/or RANDOM

VIBRATION

5 to 5,000 cps from −120°F to +600°F at 200,000 ft. altitude with automatic *controlling, programming and recording.*

also complete testing facilities for:

ACOUSTIC NOISE FACILITIES
MISSILE SHOCK TESTING SAWTOOTH, SINE, SQUARE WAVE.
Salt Spray, Fungus, Explosion, Sand and Dust, Humidity, Rain, Sunshine, Rotating Accelerator, Radio Noise, Interference.

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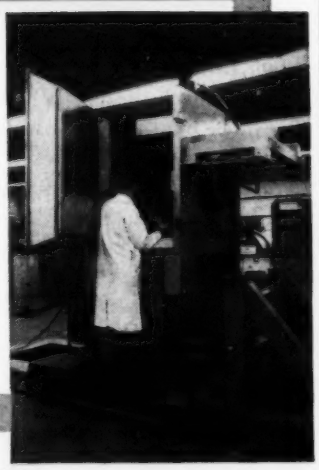
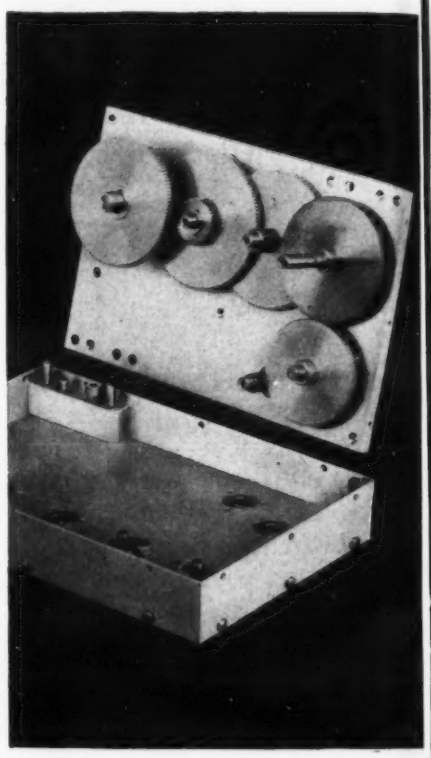


CIRCLE 50 ON READER-SERVICE CARD

PROGRAMMING FOR PRECISION

Precision is the prerequisite for meeting the ever increasing demands of this challenging age of Instrumentation and Automation. You will find the classical solution to your precision design and manufacturing problems at H.O. Boehme, Inc.



The gear train shown represents a typical Boehme answer to a specific precision problem.

• • •

We have set precision standards in custom-made gear design, engineering, and manufacture for over three decades. We will supply all your custom-made fine pitch precision gear needs —from ⅛" to 5" O.D., 180 to 16 D.P., up to A.G.M.A. Precision #3 — or to specifications named by you.

Your inquiries are welcome. Estimates based on your blueprints or sketches will be furnished, at no obligation.

H.O.Boehme,Inc.

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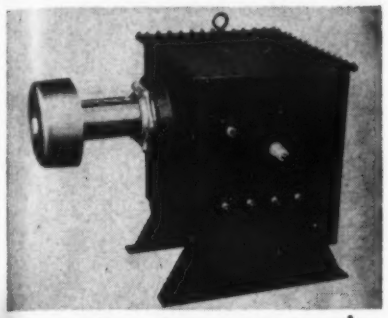
New York 10, N.Y.

CIRCLE 51 ON READER-SERVICE CARD

RADAR PULSE TRANSFORMER

Peak pulses of 32 megawatts power at 100 Kv are supplied by new oil-cooled transformer for ship-board radar applications. Open basket-type coil is self-healing in case of overload.

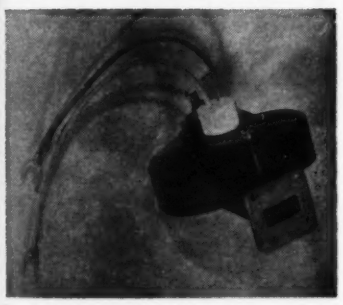


Also supplies 10 amperes for transmitting tube filament. Primary impedance 12.5 ohms, prf up to 2000 pps, pulse duration 0.5 to 5.5 μsec.—*Stavid Engineering, Inc., Plainfield, N. J.*

CIRCLE 110 ON READER-SERVICE CARD

SMALL-BOAT MAGNETRON

Type QK798 inexpensive X-band magnetron is a fixed-frequency pulsed magnetron of the non-integral magnet type with probe output. Fits in magnet-waveguide assembly which can be manufactured separately if

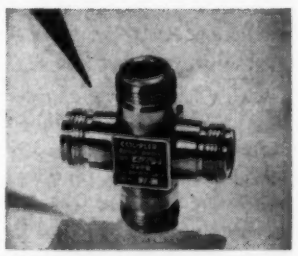


desired, in applications for small-boat or light-plane radars. Rated at minimum life of 500 hrs at 5 kv peak anode voltage, 0.2 μsec pulses, for peak power of 3 kw.—*Raytheon Mfg. Co., Microwave & Power Tube Div., Waltham* 54, *Mass.*

CIRCLE 111 ON READER-SERVICE CARD

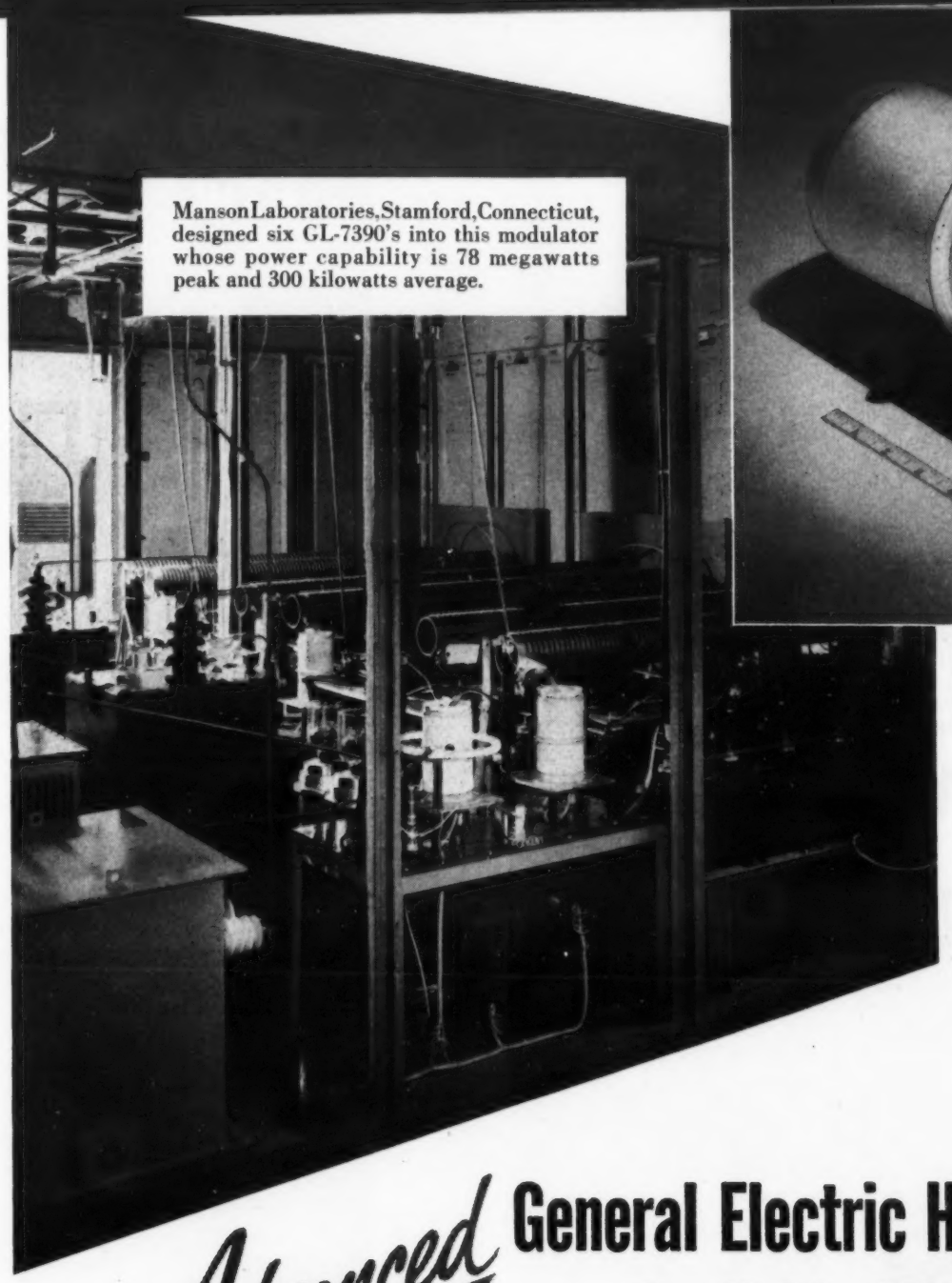
RF POWER DIVIDERS

New line of miniature Power Dividers for L, C, S and X band applications provide 2- and 3-way di-

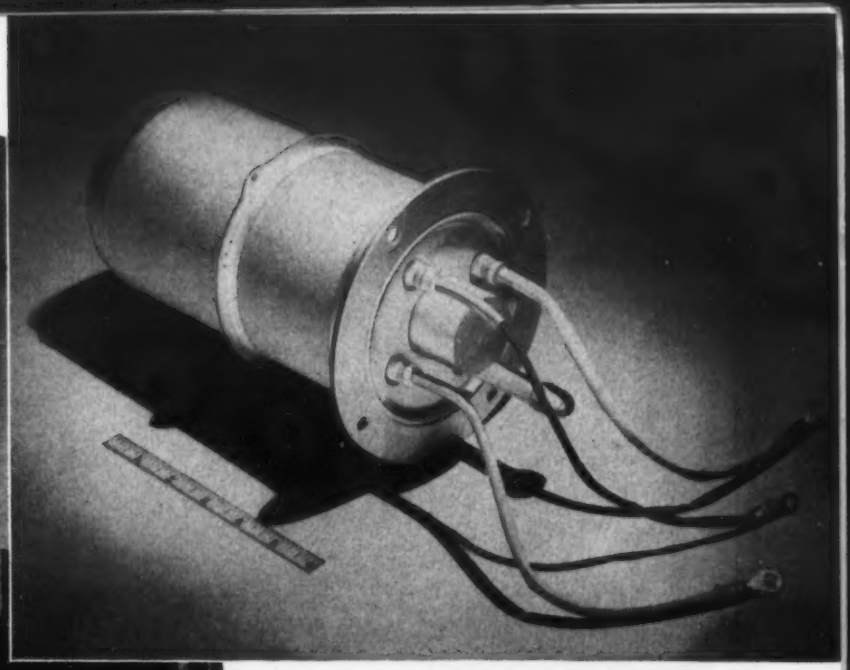


visions at 50-ohm impedance, with VSWR less than 1.3.—*Transco Products, Inc.*, 12210 *Nebraska Ave., West Los Angeles* 25, *Calif.*

CIRCLE 112 ON READER-SERVICE CARD



Manson Laboratories, Stamford, Connecticut, designed six GL-7390's into this modulator whose power capability is 78 megawatts peak and 300 kilowatts average.



Below are shown the approximate envelope sizes and power outputs of two thyratrons now in use in high-power radar, as compared to the new General Electric tube.

Type 1257	Type 5948	New G-E Development (GL-7390)
8½"x20"	5"x16"	6"x11"
Avg. Power 33KW Peak Power 33MW	Avg. Power 12.5KW Peak Power 12.5MW	Avg. Power 66KW Peak Power 33MW

CHARACTERISTICS:

Peak Anode Voltage	33 KV
Average Anode Current	4 amperes
Peak Anode Current	2,000 amperes
Anode Dissipation Factor	30 x 10^9

Advanced General Electric Hydrogen Thyratron Available NOW from Stock!

The new General Electric GL-7390 hydrogen thyratron, which has the highest known power handling capability of any hydrogen thyratron now available, can be shipped immediately from stock. Designed for high-power radar pulse modulators, the GL-7390 features metal-ceramic construction for great mechanical ruggedness, smaller size for important space savings, and ability to switch extremely high average and peak power.

The external anode and grid construction allows direct convection cooling of the anode and grid. Reduced anode and grid temperatures during operation minimize the possibility of arc-back and/or grid emission.

Ceramic-metal construction provides a rugged envelope which enables the GL-7390 to withstand shock and vibration conditions beyond the limits of glass designs. The anode and grid are in the form of solid metal cups solidly brazed to the ceramic body. This is a far stronger design than conventional glass seals and lead supports.

The metal-ceramic construction allows close, accurate, and rigidly fixed spacings of the anode and grid. The result is very reliable high-voltage operation. Application assistance available from your regional General Electric power tube office. *Power Tube Department, General Electric Company, Schenectady 5, New York.*

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OUTSTANDING FEATURES

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- All digits displayed on front surface viewing screen... quickly seen from any angle of viewing.
- All digits uniform in size and intensity... easier and faster to read.
- High-contrast viewing screen insures utmost visual sharpness.
- Digit style of your choice to complement manufacturer's original equipment.
- Colored digits of your choice for special environmental lighting.
- Individual units may be assembled in groups for convenient panel mounting.
- Dimensions: 1-9/16" wide, 2⅝" high, 5⅝" long.

PRICE PER UNIT $18.00

QUANTITY PRICES ON REQUEST

NEW! LARGE IN-LINE DISPLAY

Series 80,000

Offers same outstanding features as Series 10,000 In-Line Display, but approx. four times larger. Easily viewed over 100 feet away!

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5528 Vineland Avenue, North Hollywood, Calif.

CIRCLE 53 ON READER-SERVICE CARD

MICROWAVE CALORIMETER

New Model SME-74 Kahl Microwave Calorimeter for accurate measurement of RF average power over

the 100 watt to 50 kw range over all frequencies from 1000 mc to 75 kmc, and for peak powers over 50 megawatts; also serves as safe absorptive load when testing high power transmitters.—*Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif.*

CIRCLE 113 ON READER-SERVICE CARD

REVERSIBLE VARACTOR DIODES

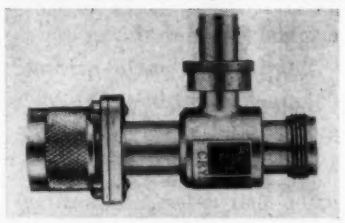
New series MA-450 hermetically-sealed Varactor diodes use a base adaptor to achieve reversible polarity. Power dissipation rating ranges from 300 mw for lowest cutoff types

to 150 mw for highest cutoff types. Are used as amplifying elements in parametric amplifiers; balanced single sideband modulators; subharmonic generators (Parametrons); RF limiters; etc.—*Microwave Associates, Inc., Burlington, Mass.*

CIRCLE 114 ON READER-SERVICE CARD

COAX CRYSTAL SWITCH

New Microwave Coaxial Crystal Switch has over 30:1 closed-to open db ratio. 16.5 milliwatt power requirement and 10 mμsec switching



speed qualify switch for high speed antenna lobe switching, microwave chopping for crystal video detection of RF, and high speed switching in computers over −55° to 71°C range.—*American Electronic Labs. Inc.*, 121 *N. 7th St., Philadelphia 6, Pa.*

CIRCLE 115 ON READER-SERVICE CARD

2 NEW Chassis-Trak Slides

Engineering progress at Chassis-Trak, keeping pace with the equipment mounting needs of the electronics industry, has resulted in two new slide designs. They are:

1¾-inch slide

Ideal for light-duty slide applications—loads up to 50 lbs. Chassis-Trak "pencil thin" design plus an overall height of only 1.687" saves cabinet space, permits easy mounting without cabinet modification. Cadmium-plated cold-rolled steel construction. Phenol epoxy coating provides permanent dry lubrication. Tilt and non-tilt styles in eight standard lengths—10, 12, 14, 16, 18, 20, 22 and 24 inches.

Lightweight slide

Newly developed model for special equipment mounting problems. Exceptionally compact (1" high, ½" wide), yet supports up to 150-lb. loads. Saves space without sacrificing heavy-duty strength. Low in cost, easy to install. All stainless steel construction. Precision roller and ball bearings for effortless operation.

Check with Chassis-Trak engineers for the solution to your rack or cabinet application. Slides available in tilt, non-tilt, and tilt-lock models. Supports up to 275 lbs.

chassis Trak inc.

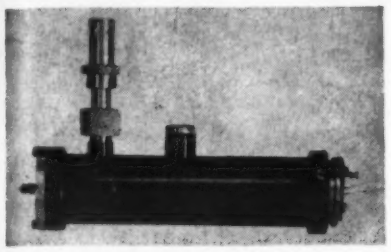
For further information contact:

525 S. Webster, Indianapolis 19, Indiana

CIRCLE 54 ON READER-SERVICE CARD

S-BAND CAVITIES

Miniaturized S-band TRAK Oscillator Cavities for RCA 5893 pencil triode/ruggedized are designed for 1 kw peak power output. With stabili-



ties from ±2% to ±10% and weighing only 8 oz, they often are used in missile beacon systems.—*CGS Laboratories,* 391 *Ludlow St., Stamford, Conn.*

CIRCLE 116 ON READER-SERVICE CARD

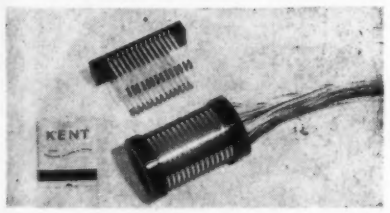
MICROWAVE FILTERS

New standard line of High- and Low-pass microwave filters with peak power capacities to 2 Kw, are said most compact yet available for that rating. Low-pass filters are 13- element networks in 1 db down frequencies of 500, 1200, 2300, 3100 and 6000 mcs. High-pass filters are 7-element networks available in 1 db down frequencies of 400, 900, 2000, 2700 and 5400 mcs. Max insertion loss in pass band is 0.5 db, with input VSWR of 1.5:1 or less within the pass band.—*Frequency Standards Div., Harvard Industries, Inc., P. O. Box* 190, *Red Bank, N. J.*

CIRCLE 117 ON READER-SERVICE CARD

ANTENNA SLIP RINGS

Standard slip ring and brush assemblies for rotary antenna arrays with noble metal rings, hi-temperature dielectric, beryllium copper brush



leaves, and silver graphite brushes are furnished with from 3 to 40 circuits to fit shafts from ¼" to 1" diameter.—*Rotary Devices Corp.,* 40 *Jay St., Englewood, N. J.*

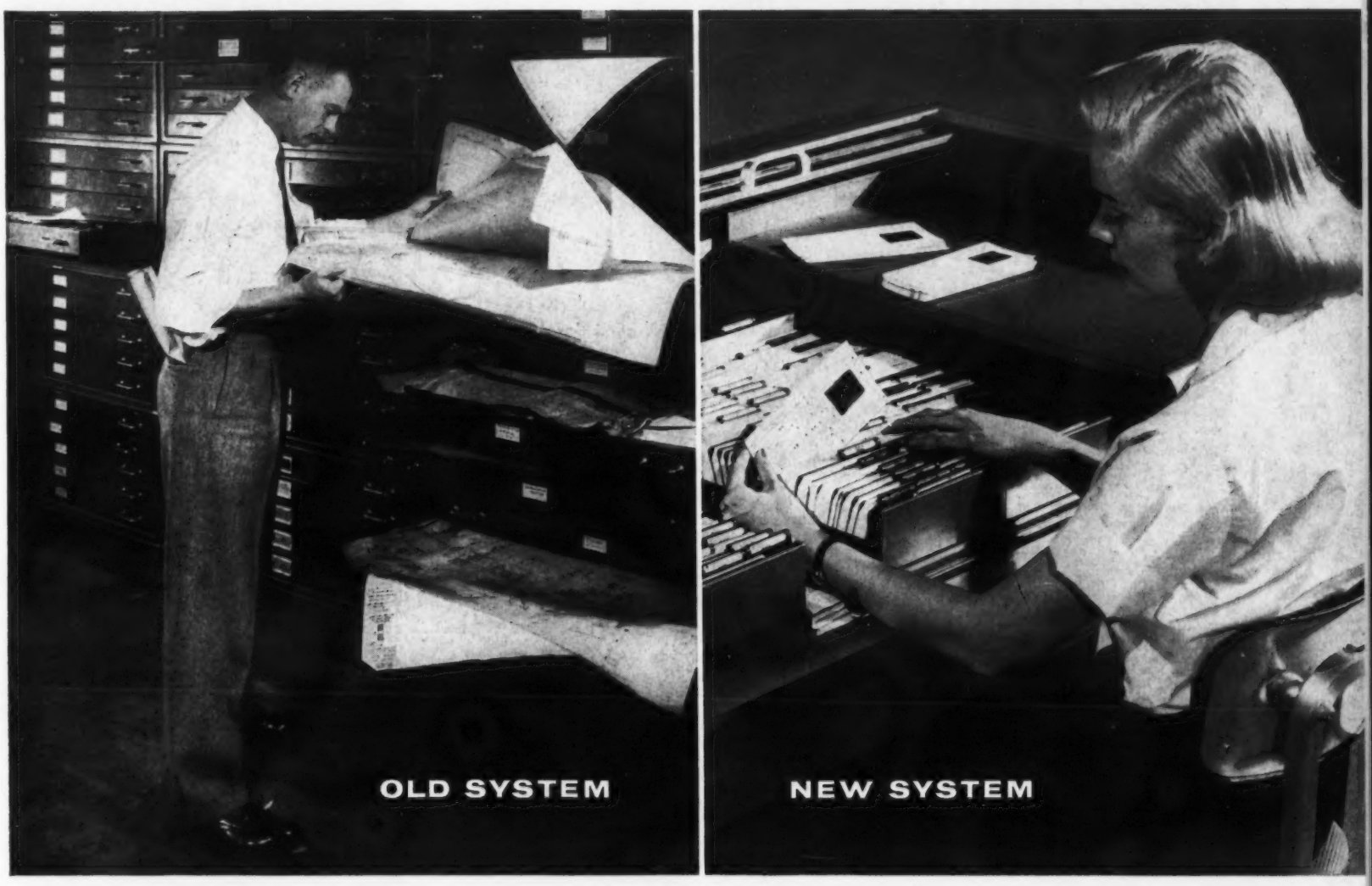
CIRCLE 118 ON READER-SERVICE CARD

COMMAND RECEIVER

New all-transistor receiver-decoder featuring crystal-controlled frequency coverage of 400-550 mc range is designed for missile command destruct use requiring minimum weight, size and power consumption. Details on request.—*Babcock Radio Engineering, Inc.,* 1640 *Monrovia Ave., P. O. Box* 344, *Costa Mesa, Calif.*

CIRCLE 119 ON READER-SERVICE CARD

thanks to *automatic* xerography...



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How would you like to reduce—by as much as 95%—the storage space you now allot to active and inactive engineering drawings?

In so doing, you'll also reduce time and labor costs dramatically. Savings as high as $100,000 a year can be achieved because of a spectacular breakthrough in storage and reproduction techniques.

This development, called a unitized microfilm system, has three basic steps: microfilming original drawings or changes; mounting individual frames into die-cut apertures of data-processing cards; and, from the cards, automatically enlarging the microfilmed drawings by xerography, fast and economically, in a XeroX® Copyflo® 24C continuous printer.

Dry, positive prints, translucent intermediates, or offset paper masters emerge at the rate of 20 feet a minute. They are automatically cut, and ready for immediate use.

The aperture cards, which may be machine-sorted for any combination, are stored in miniature working files, occupying only a tiny fraction of the space required by blueprints, intermediates, or originals.

There is no refiling. The quality of xerographic prints is superbly high, yet they are so inexpensive that engineers are urged to discard them after use.

Unitized microfilm systems offer many other striking economies in time, money, and materials. Our booklet X-287, showing the many benefits, is yours for the asking. Write HALOID XEROX INC., 60-198X Haloid St., Rochester 3, New York. Branch offices in principal U. S. and Canadian cities.

Overseas: Rank-Xerox Ltd., London.

PUSH THE BUTTON...AND COPIES FLOW!

CIRCLE 55 ON READER-SERVICE CARD

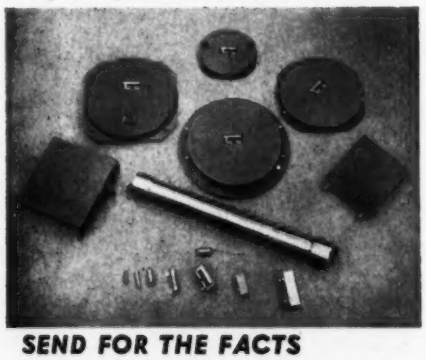
HALOID XEROX®

LFE makes a DELAY LINE for almost every purpose!

Ordinary, every day delay problems? Please don't ask us for help!

But if your problems include choosing the right delay lines for computer applications, airborne or ground radar MTI systems, missile systems, lock-test or range markers, or you name it, LFE has a delay line design that will do the job.

There's 12 years of experience behind LFE's quartz and mercury delay lines. That's your assurance of reliability and proven design when you buy delay lines from LFE.



SEND FOR THE FACTS

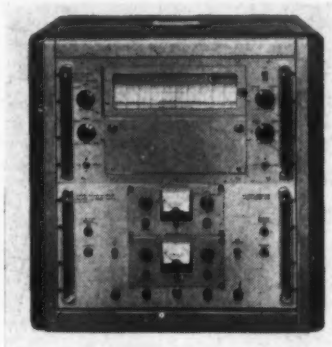
Write for full information on LFE's complete line of delay lines.

LABORATORY FOR ELECTRONICS, INC.
Computer Products Division
1079 Commonwealth Ave.
BOSTON

CIRCLE 56 ON READER-SERVICE CARD

ANTENNA PATTERN RECORDER

New APR-20 series Antenna Pattern Recorders include db meter for signal level monitoring, noise compression circuits, writing speed over



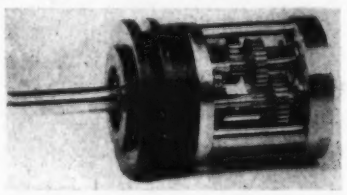
40"/sec and plug-in pen balance potentiometer and amplifier modules to provide maximum operating flexibility.—*Scientific-Atlanta, Inc.* 2162 *Piedmont Rd., N.E., Atlanta* 9, *Ga.*

CIRCLE 120 ON READER-SERVICE CARD

ACTUATORS AND SERVOMECHANISMS

SPEED CHANGERS

New standard gear heads, speed reducers and speed increasers conforming to Mil-specs and operating from —55° to 150°C have 30 minutes

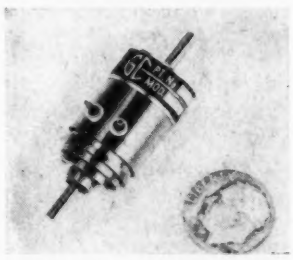


max backlash in any ratio, use sleeve or ABEC 7 ball bearings; available with preset slip clutch.—*Kinetic Instrument Corp.*, 1070 *Linwood St., Brooklyn* 8, *N. Y.*

CIRCLE 121 ON READER-SERVICE CARD

SUB-MIN CLUTCHES

New sub-miniature clutches and brakes for computer, control and servo positioning features high reliability with extra small size and

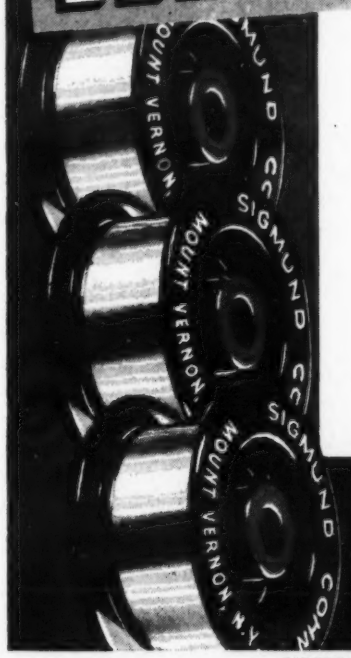


weight. Series 6 and 8 clutches and brakes feature zero backlash, and endplay and elimination of sliprings. Meet applicable Milspecs.—*Guidance Controls Corp.*, 110 *Duffy Ave., Hicksville, L. I., N. Y.*

CIRCLE 122 ON READER-SERVICE CARD

Very Small Wire — Specialists in the Unusual

ELECTROPLATED

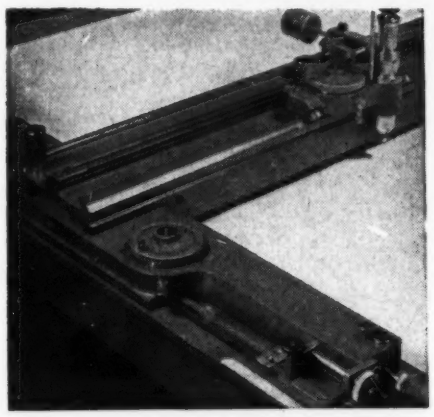


Unusual and difficult engineering problems may be solved, at times, by single or multiple electroplating of small wires . . . A wide variety of metals is available, both as the core wire and as the plate. Inquiries invited.

SINCE 1901

SIGMUND COHN MFG. CO., INC.
121 SOUTH COLUMBUS AVENUE.
MOUNT VERNON, N. Y.

CIRCLE 57 ON READER-SERVICE CARD



A BETTER PLOTTER

for Precision Layout of Grid Systems and Coordinate Positions

The Coordinatograph, a new, better plotting instrument, is now being used for all types of precision layouts. It plots within .001" over a 47½" x 47½" working table. Rack and pinion construction for counter dials assures accurate measurements. 7 diameter pricker microscope permits observation and plotting in one operation. Radii from 12" to 40" can be plotted with beam compass. Vertically laminated plywood table. Vibration-free tripod mount. Write now for free folder.

AERO SERVICE CORPORATION
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CIRCLE 58 ON READER-SERVICE CARD

Quality.
miniature & sub-miniature
Hermetically Sealed

thermostats

Illustrated here are the results of 25 years experience in the thermal control field. All Chatham Thermostats have a patented positive contact wiping action for longer life.

WIDE VARIETY TO MEET MILITARY and INDUSTRIAL APPLICATIONS

- Insulated and grounded models
- Close differential—long life
- Sizes 3/16" & 1/4" dia.
- Tin plated brass cases
- Adjustable from -65°C to 150°C—Specials to 235°C max.
- Special mounting brackets to customer specs.

Write or phone for technical bulletin

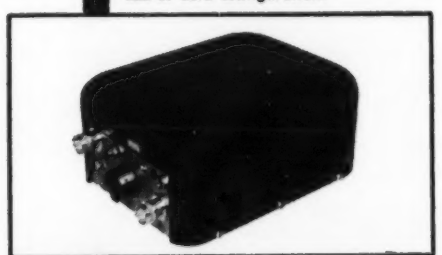
***CHATHAM CONTROLS* CORP.**

136 River Road, Chatham, N. J., CRestview 3-7300

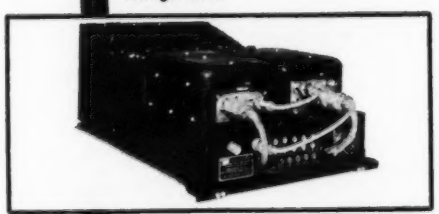
CIRCLE 59 ON READER-SERVICE CARD

D....DORSETT
A....Airborne
T....Telemetering
A....Accuracy

ACTUAL SIZE! . . . O-8 V.C.O. All-silicon transistors. Circuit design offers excellent stability and linearity. Available in all standard RDB channels. In can or card configuration.



A-25 RF Power Amplifier; 25 w output with 2 w or less input drive. 2¼ high by 5" x 3¾" plus connectors. PS-31 Power Supply and TR-4 and TR-12A Transmitters also have this configuration.



TMS-106, 10-channel, tube-type system with 25 watts output, typical of the airborne package design ability in FM/FM PM/FM systems available from Dorsett.

For your telemetering requirement, whether missile, aircraft, drone, or balloon, DORSETT provides proved facilities for accurate evaluation, intensive research, rapid adaptation and final production.

Geared to meet quantity demands, DORSETT is still able to keep vital engineering liaison on a close, progressive basis. Specifications on standard telemetry components and typical systems available on request.

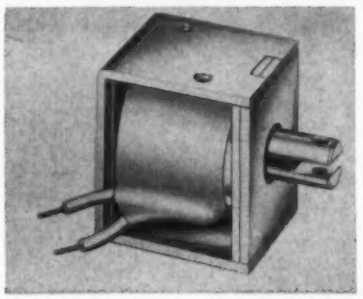
TEL. JE 4-3750

DORSETT Electronics Laboratories, Inc.
Box 862 Norman, Okla.

CIRCLE 60 ON READER-SERVICE CARD

MIDGET AC/DC SOLENOID

New No. 28 Midget solenoid available for intermittent or continuous, ac or dc duty; provides plunger

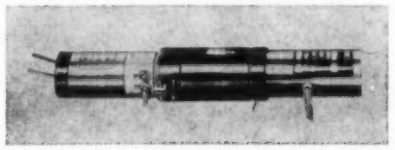


strokes from 1/16" to ½" with lift of over 41 oz. Weight is 3.5 oz.—*Guardian Electric Mfg. Co.*, 1621 *W. Walnut St., Chicago* 12, *Ill.*

CIRCLE 123 ON READER-SERVICE CARD

MODULAR SERVO

New Size 8 Modular prepackaged Type E-108A assembly comprises

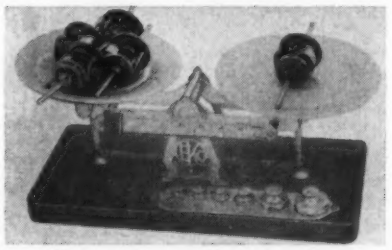


motor generator, gear train, synchro and potentiometer for air servo use. —*John Oster Mfg. Co., Avionic Div.*, 1 *Main St., Racine, Wisc.*

CIRCLE 124 ON READER-SERVICE CARD

BERYLLIUM GEARS

Four Beryllium gears have weight equal to single steel gear of comparable strength, construction. Gears,



gyro housings and gear assemblies for all types of missile applications are available from manufacturer of beryllium components. Catalogs available.—*Leemath, Inc., Syosset, N. Y.*

CIRCLE 125 ON READER-SERVICE CARD

ELECTRIC ACTUATOR

New miniature electric actuator line for linear and rotary applications are available for ac or dc motors meeting Mil-spec requirements. Low

backlash, accurate positioning, adjustable limit switches, and gear train are featured, with brake if required. —*Nash Controls, Inc.*, 69-73 *Summit St., Newark* 3, *N. Y.*

CIRCLE 126 ON READER-SERVICE CARD

IN THE LABORATORY

ON THE PRODUCTION LINE

TEST SHOCK WITH CVC HYGE

You can produce and reliably repeat today's widest range of shock waveforms—half-sine, ¼ cosine, sawtooth, square and combinations—with CVC HYGE.

You'll find a HYGE model to meet your requirements for laboratory *or* production line use. With HYGE, you'll have a compact source of stored energy at your fingertips for producing shock waveforms to meet most test specifications—and at a cost of only pennies per test. As new requirements develop, HYGE lets you adapt to them by adding a simple metering pin.

HYGE 6000	Large laboratory model. Thrust capacity to 40,000 lbs.; acceleration, 2000G.
HYGE 3000	Small laboratory model. Thrust capacity to 10,000 lbs.; acceleration, 500G.
NEW PRODUCTION LINE HYGE	Thrust to 15,000 lbs.; acceleration, 100G. Provides most widely specified shock pulses: MIL-E-5272A (11 ±1 ms half-sine) and Ramo-Woolridge (6 ±0.5 ms Sawtooth). 5 tests in 5 minutes at less than 5¢ per test.

WRITE for HYGE Bulletins. Or, outline your requirements and ask for a specific recommendation.

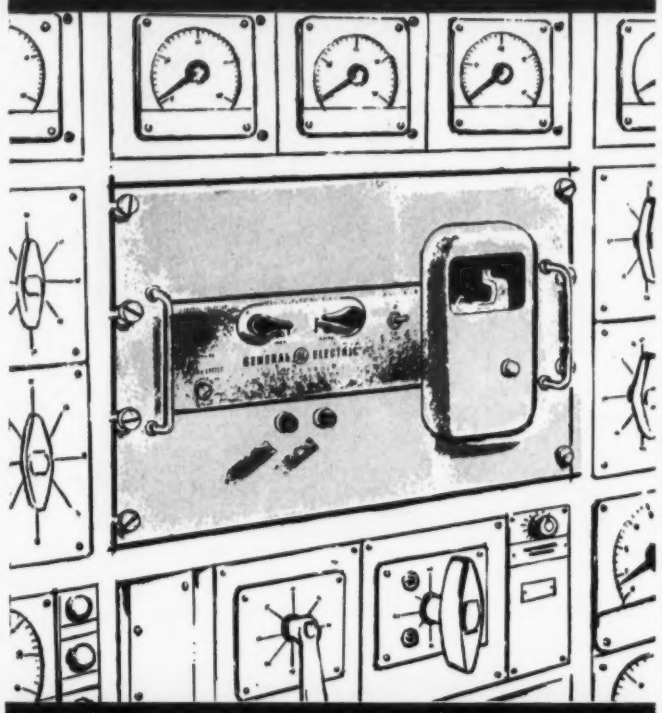
Consolidated Vacuum Corporation

ROCHESTER 3, NEW YORK

A SUBSIDIARY OF CONSOLIDATED ELECTRODYNAMICS CORPORATION (FORMERLY ROCHESTER DIVISION)

CIRCLE 61 ON READER-SERVICE CARD

For Reliable Voltage Control



NEW

General Electric Rack-Mounted Inductrol* Voltage Regulators

For Voltage-sensitive Electronic Loads

Ratings (automatic or motor-driven) up to 15 circuit kva—100 load amps, single-phase 50/60, and 400 cycles, 120 and 240 volts.

FEATURES

- Built to meet MIL specifications
- No brushes
- No harmful waveform distortion
- Drift-free tubeless controls
- 1% bandwidth accuracy
- Voltage adjustment up to 100%
- Compact—high capacity
- Temperature, power factor, and frequency compensated
- Highly reliable

FOR MORE INFORMATION about the complete line of G-E Inductrol regulators to meet your application, contact the General Electric voltage regulator representative at your nearby G-E Apparatus Sales Office, or write to Section 425-26, General Electric Company, Schenectady 5, N. Y.

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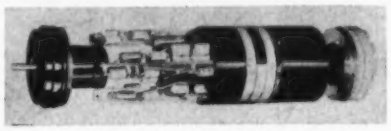
Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 62 ON READER-SERVICE CARD

AMPLIFIER/RESOLVER MODULE

Miniaturized amplifier/resolver only three inches long consists of size 8 winding-compensated resolver concentric with a dual channel ampli-

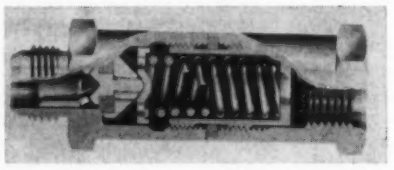


fier, all within a size 15 frame. Designated the AMPLISOLVER, it provides 1:1 transformation ratio, trimmed to ±2% over a −55° to 125°C temperature range. Input impedance is 1 megohm min with output impedance of 270 +j400 ohms.—*Instrument Div., American Electronics, Inc., 9503 W. Jefferson Blvd., Culver City, Calif.*

CIRCLE 127 ON READER-SERVICE CARD

CRYOGENIC RELIEF VALVE

New Model K5120T stainless steel relief valve for LOX or liquid nitrogen system is available with cracking pressures ranging from 100 to

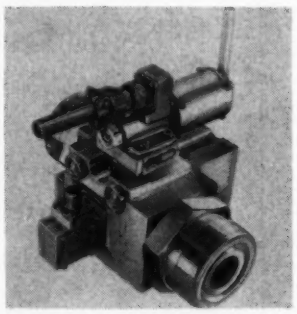


2400 psi, and in tubing connection sizes from ¼" to 1". Smooth throttling on opening and closing at temperatures down to −320°F is said to assure totally reliable operation.—*James, Pond & Clark, Inc., 2181 East Foothill Blvd., Pasadena, Calif.*

CIRCLE 128 ON READER-SERVICE CARD

SUB BALLAST VALVE

Remote 1-man control of 4500 psig ballast air from new atomic submarine control console is accomplishment of new Model MV-173 electric



valve. Replaces several men formerly needed to operate hand valves for diving and climbing control. Has manual override for emergency operation, also poppet switch for indicating open position. Operates on 110-125 v ac, has capacity equivalent to sharp-edge orifice 1.050" I. D.—*Marotta Valve Corp. P. O. Box 330-48, Boonton, N. J.*

CIRCLE 129 ON READER-SERVICE CARD

NEW NEW

MULTIMEGAWATT SWITCHES for radar applications

AMCI Type 1038-HV for 6⅛" lines
Type 1136-HV for 3⅛" lines

For use in Rigid Coaxial Transmission-Line Systems at VHF and UHF

CW rating is approximately that of the mating transmission lines. Switches available in either motor-driven or manually operated models.

Write for complete information on AMCI Coaxial Switches

AMCI ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS
ALFORD Manufacturing Company 299 ATLANTIC AVE., BOSTON, MASS

CIRCLE 63 ON READER-SERVICE CARD

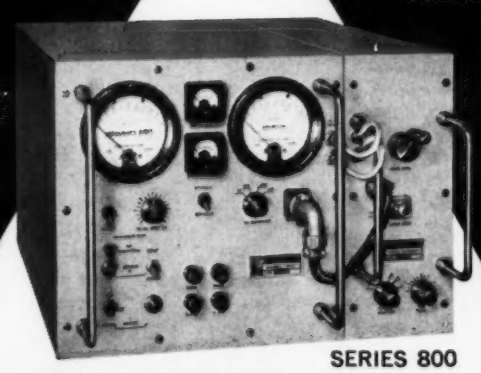
From PITLOG –

STALO STABILITY TESTER

Accurate to 1 part in 10^9

Measures short term deviation and long term drift from UHF to 10,000 mc. Checks stability of radar systems components — stalos, cohos, IF's, klystrons and other stable signal sources — either on production line or in the field. Particularly useful in design, test and maintenance of MTI radars.

A VERSATILE MICROWAVE STABILITY TESTER... DESIGNED FOR ANY APPLICATION REQUIRING PRECISE MEASUREMENT OF FREQUENCY STABILITY.



SERIES 800

On demonstration at IRE Booth 3024.

PITLOG

Other PITLOG components — Tunable Stalos — stable local oscillators covering UHF, L-,S-,C-, or X Band frequencies.

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237 Lafayette Street New York 12, N. Y. CAnal 6-7250
Advanced Instrumentation Since 1927

Write for Bulletin MS-2

CIRCLE 64 ON READER-SERVICE CARD

HYDRO SELECTOR VALVES

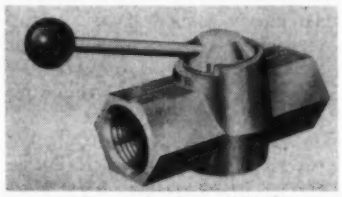
Four-way 3-position HP348100 (left) is spring-loaded-to-neutral for use in a 3000 psi, 65° to 275°F hy-

draulic system. Model HP574100 (right) is the 4-way, 2-position spring-loaded version.—*Hydra-Power Corporation, Pine Court, New Rochelle, N. Y.*

CIRCLE 130 ON READER-SERVICE CARD

"O" RING-SEAL VALVE

New 9200 series Plug Valve uses 3 "O" rings of Buna-N or Neoprene; two at ends of plug and one in lipped

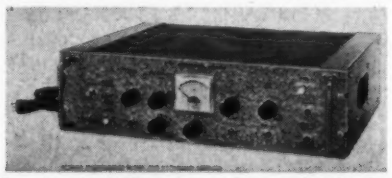


groove on face of plug, 90° from plug flow passage to give dead tight seal when plug is closed. Available in brass, aluminum or 303 stainless.—*Circle Seal Products Co., Inc., E. Foothill Blvd., Pasadena, Calif.*

CIRCLE 131 ON READER-SERVICE CARD

LEVELER AMPLIFIER

New broadband Model 700 dc leveler amplifier used with an external crystal detector and directional cou-

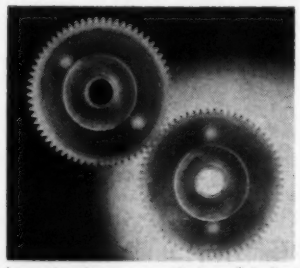


pler holds RF output from single frequency or swept microwave sources constant within ±0.1 db.—*Alfred Electronics, Inc.*, 897 *Commercial St., Palo Alto, Calif.*

CIRCLE 132 ON READER-SERVICE CARD

PLASTIC GEARS

New Rexolite #1422 cast plastic gears of high stability are designed for use in airborne and microwave



metering devices requiring high radiation resistance and chemical inertness. —*The Rex Corp., West Acton, Mass.*

CIRCLE 133 ON READER-SERVICE CARD

CIRCLE 65 ON READER-SERVICE CARD

Chart-Pak Tapes for Printed Circuits . . . now in NEW TAPE-SAVER DISPENSER

(at no extra cost)

ONLY CHART-PAK HAS IT!
Keeps tape edges clean
No waste . . . use every inch
Easy spindle storing
Protected from damage

Make conductor patterns and terminal pads for printed circuit layouts in minutes! Chart-Pak tapes and symbols are precision slit to .002". High dimensional stability. Non-reflective, opaque black surface. Adhesive backing holds firmly, will not melt under heat of reproduction; yet can be easily lifted and re-applied for corrections. Available in tape widths of 1/32" and up, and in die-cut lands, fillets, corners, tear drops, etc. Ideal for use on any surface, especially Chart-Pak precision grids.

Write for full details or consult your Yellow Pages under "Charts-Business."

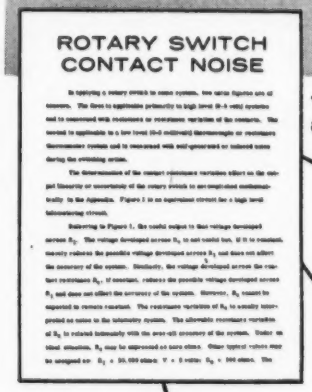
Saves time . . .
Saves money!

CHART-PAK, INC.
ORIGINATOR OF THE TAPE METHOD OF DRAFTING
1510 River Road, Leeds, Mass.

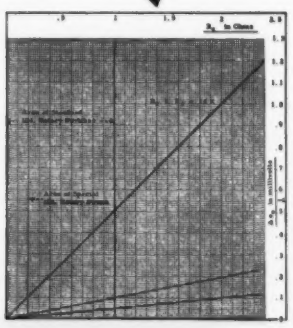
CIRCLE 66 ON READER-SERVICE CARD

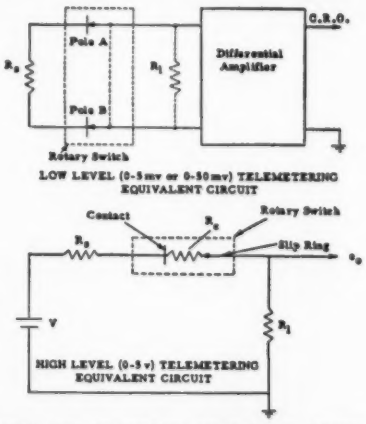
How Do YOU Define Switch Noise?

Here's how IDL analyzes it!


ROTARY SWITCH CONTACT NOISE

These data are important considerations in switch applications and provide you with valuable criteria for systems evaluation.





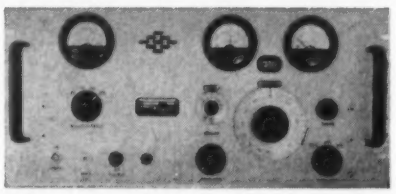
IDL quality control and inspection procedures insure that these "Standards of Excellence" are maintained in the production of high speed, sealed rotary switches for critical applications. Typical products are indicated by these units.

Write IDL for your free copy of "Rotary Switch Contact Noise"
SEE US IN IRE BOOTH #2106
INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Subsidiary of Royal McBee Corporation
54 MECHANIC STREET, ATTLEBORO, MASSACHUSETTS, U.S.A.

CIRCLE 67 ON READER-SERVICE CARD

VERSATILE TELEMETRY RECEIVER

New Type 11B1 Telemetry Receiver designed for FM/FM, PDM/FM and PCM/FM systems has noise figure under 7 db over 216-256 mc band.



Either crystal-controlled or continuously-tunable modes of operation with vernier compensation for frequency drift are available. Relay rack mounting, 8¾" high x 15" deep.—*General Electronic Laboratories, Inc.*, 8521 *Second Ave., Silver Spring, Md.*

CIRCLE 134 ON READER-SERVICE CARD

SUB-SUBMIN OSCILLATOR

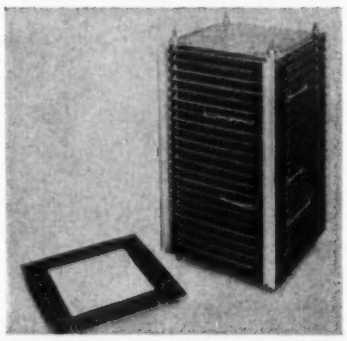
New transistorized voltage-controlled subcarrier oscillator Model TOE-300, for FM/FM telemetry uses only 20v dc at 5 ma, occupies only 1.5 cu-in. Available in all IRIG num-

bered and lettered bands, its output is accurate to within 1% over a temperature range of 25° to 85°C and while subject to accelerations of ±25 G.—*Bendix-Pacific Div., Bendix Aviation Corp.*, 11600 *Sherman Way, N. Hollywood, Calif.*

CIRCLE 135 ON READER-SERVICE CARD

MILITARY MEMORY

Magnetic core memory stack designed to withstand Missile vibration and shock is designated MIL-STAK.

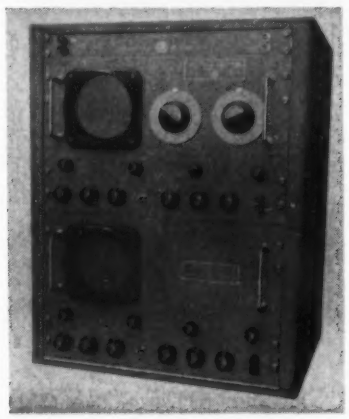


Molded plastic frame receives cores wired by locked link method. Completed stack is encapsulated in polyurethane for max strength.—*Telemeter Magnetics, Inc.*, 2245 *Pontius Ave., Los Angeles* 64, *Calif.*

CIRCLE 136 ON READER-SERVICE CARD

TELEMETERING ANALYZER

New Model TA-100L-120L displays all FM/FM subcarrier channels on Log-scan tube while second, linear scan tube analyzes individual portions



of spectrum. Marker signal on log scan shows location of section under linear scan. Log and linear scanners also available separately.—*Probescopes Co., Inc.*, 8 *Sagamore Hill Dr., Port Washington, N. Y.*

CIRCLE 137 ON READER-SERVICE CARD

AUDIO CHANNEL SEPARATORS

Modular audio filters for multichannel band separation having center frequencies of 1.05, 3.78, 106, 21.6, 36.7 and 52.6 kc are available in mod-

ules 2-¼" x 2-⅛" x 4" high. Typical unit BF-118 has CF of 21.6 kc, and band-width shape factor of 2.65. Input/output impedances are 2000 ohm, insertion losses less than 2 db.—*Control Electronics Co., Inc.*, 10 *Stepar Pl., Huntington Station, L. I., N. Y.*

CIRCLE 138 ON READER-SERVICE CARD

SUBMIN COMMUTATOR

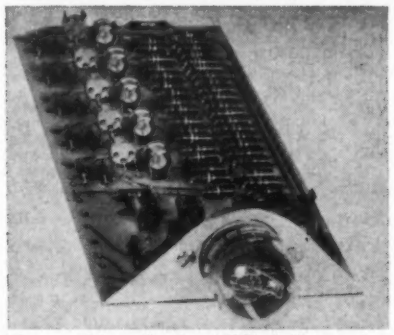
New 30 x 10 2-pole Telemetering Commutator for PAM systems is said to show less than 0.3% noise levels with millivolt input signals for a life

over 1000 hours. Motor is driven by 115 v 400 cps current; complete units meets missile environmental tests.—*Instrument Development Laboratories, Inc.*, 67 *Mechanic St., Attleboro, Mass.*

CIRCLE 139 ON READER-SERVICE CARD

NUMERIC DISPLAY CONVERTER

New Solid-state converter Model 260 responds to four-bit binary codes to activate decimal display tube of

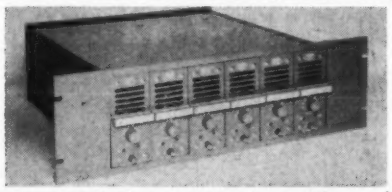


either cold-cathode ("Nixie" type) or filamentary projected (IEE Alpha-Numeric) type. All relays, tubes and preventive maintenance are said eliminated.—*Hermes Electronics Co., 75 Cambridge Pkwy., Cambridge 42, Mass.*

CIRCLE 140 ON READER-SERVICE CARD

DIFFERENTIAL AMPLIFIER

New solid-state differential dc amplifier, Type 1-102, with input and output isolated from each other and from ground, eliminates ground loop

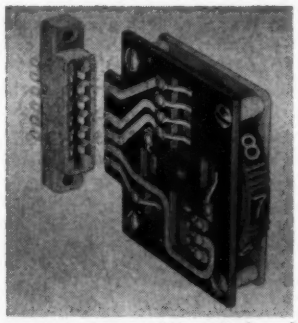


and circulating current problems in data processing systems. Common mode rejection of 10^9:1 and stability of 0.05% are claimed; six amplifiers fit in 19" rack module.—*Neff Inst. Corp., 2211 E. Foothill Blvd., Pasadena, Calif.*

CIRCLE 141 ON READER-SERVICE CARD

BINARY THUMBWHEEL SWITCH

New modular 10-position binary thumbwheel switch requires only ½" panel space, provides 3 or 4-bit binary and complementary outputs of the numeral exposed through the bezel window. Aluminum mounting frames



accommodate up to 16 switches in line plugging into fixed printed circuit receptacles, or fixed type with solder terminals. is available.—*Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.*

CIRCLE 142 ON READER-SERVICE CARD

DIGITAL INCREMAGS

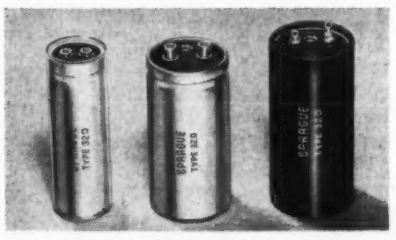
New Incremags are miniature digital components; perform counting-dividing functions otherwise requiring a battery of binary-type units. Have a variable counting rate of up to

100,000 pps and accept random or uniformly spaced inputs. Outputs in ratios of 1/1, 1/10, 1/100, 1/1000 1/10,000 and 1/100,000. A mixture of counts (up to 16 per stage) other than decade is available.—*General Time Corp., Research Lab., 107 Lafayette St., New York 13, N. Y.*

CIRCLE 143 ON READER-SERVICE CARD

RELIABLE ELECTROLYTICS

New Type 32D Compulytic Aluminum Electrolytic capacitors are manufactured to meet 85°C operating conditions, also in special designs to ob-

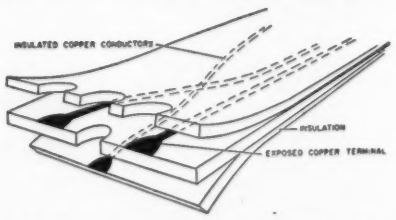


tain unusual frequency characteristics and very low ESR values where desired. Capacitor banks as large as 1 farad have been constructed using 32D capacitors. Engineering bulletin available.—*Sprague Electric Co., North Adams, Mass.*

CIRCLE 144 ON READER-SERVICE CARD

FLEXIBLE ETCHED CIRCUITRY

New custom-designed flexible Etched Circuitry, can be produced in straight cables or complex wiring patterns, in single or multi-layer constructions. Circuits can be formed in



an infinite variety of metallic etched patterns, sandwiched between two or more layers of a suitable plastic, depending on the application. Available in production quantities.—*International Resistance Co., 401 North Broad St., Phila. 8, Pa.*

CIRCLE 145 ON READER-SERVICE CARD

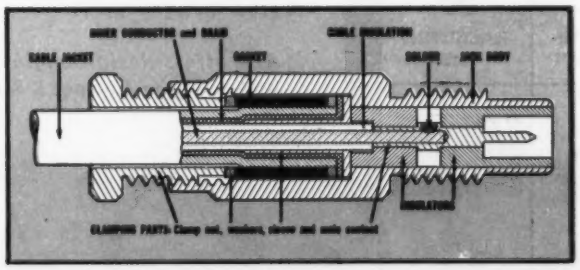
A connector so superior in concept and performance most major manufacturers are specifying it.

Mechanically, the ConheX provides a connection stronger than the cable itself. Captivated contacts assure proper engagement of mating parts. Completely field repairable for true practicability.

Extremely stable and reliable under operational conditions. ConheX offers more than any existing connectors of corresponding types, yet they are completely interchangeable.

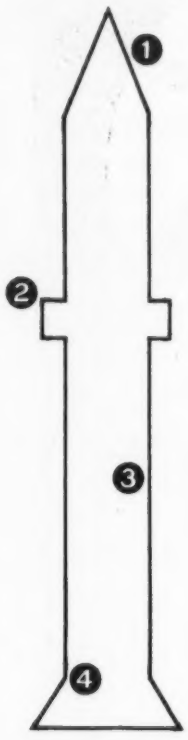
Available in 50, 75 and 93 ohm sizes in a complete range of types. Write for complete details on these vastly superior rf subminiature connectors...

The inside story of ConheX superiority. Positive clamping action distributes holding action on jacket, shield and conductor of coaxial cable—different, and far better.



Sealectro CORPORATION
139 HOYT STREET · MAMARONECK, N. Y.
PRESS-FIT TEFLON TERMINALS
CONHEX RF CONNECTORS
British Branch: Sealectro Corporation, Hersham Factory Estate, Lyon Road, Walton-on-Thames, Surrey, England.

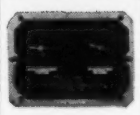
CIRCLE 68 ON READER-SERVICE CARD



ATC COMPONENTS HAVE BEEN DESIGNED FOR THESE TYPICAL MISSILE APPLICATIONS

1. ABSOLUTE PRESSURE PICKOFF
2. ACCELEROMETER
3. HYDRAULIC SERVO VALVE FEEDBACK
4. POSITION SENSING

Other ATC mil spec timing and programming components are used with Mace, Matador, Thor, Bomarc, Hound Dog.



MAXIMUM TIME-OFF INDICATOR

TRANSISTORIZED TIMER

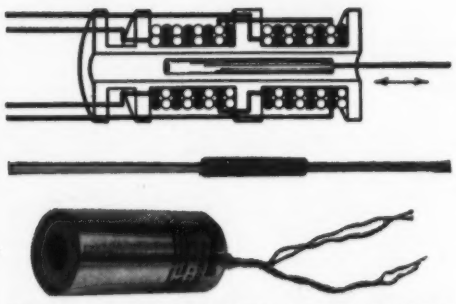
RESET TIME DELAY RELAY

WIND TUNNEL CONTROL

PROVEN ATC DIFFERENTIAL TRANSFORMER SYSTEMS

DRAMATICALLY INCREASE RELIABILITY

OF AIR & GROUND CIRCUITS



WHAT IS A DIFFERENTIAL TRANSFORMER?

An electromechanical device which translates the displacement of a magnetic armature into a linear alternating current voltage.

WHAT ARE ITS ADVANTAGES?

It's frictionless, offers infinite resolution, high signal to noise ratio, low null voltage, not affected by wide temperature ranges or radiation exposure, one-tenth of 1% linearity, small size, light weight.

WHERE ARE ATC DIFFERENTIAL TRANSFORMER SYSTEMS BEING USED?

In both airborne and ground support assemblies as components or full systems on Terrier, Jupiter LOX level controls and launching rig deflection, direct reading altimeters, G.E. countermeasure program, jet carburetor safety control.

HOW DO I FIND OUT HOW DIFFERENTIAL TRANSFORMERS WILL HELP ME?

Ask about the Aero Transducer Kit, which permits you to experiment with a broad variety of transducers applicable to rate gyros, pressure pickoffs, accelerometers, hydraulic servo valve feedbacks, position sensors.

Also send for the new 1960 ATC Condensed Catalog D-31.

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KING OF PRUSSIA, PENNSYLVANIA

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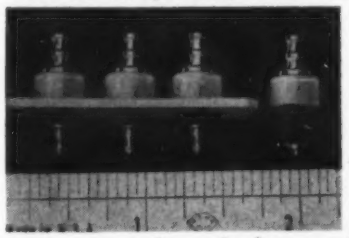
CIRCLE 69 ON READER-SERVICE CARD

HERMETIC TERMINAL

New Type 599 non-turning hermetic terminal for components in the 1500v



operating range is a single assembly without loose parts.—*Lundey Associates, 694 Main St., Waltham 54, Mass.*

CIRCLE 146 ON READER-SERVICE CARD

CERMET TRIMMING POT

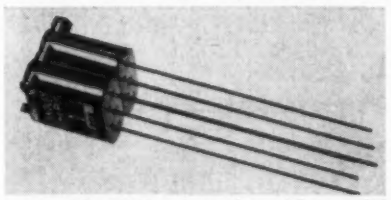
New Series 50 Helitrim Potentiometer uses conductive resistance element fused to a steatite frame to

achieve high reliability over ambients −55° to 200°C, and high insensitivity to vibration and shock. Available in standard resistances from 100 to 20,000 ohms with only 2 ohms max end resistance.—*Helipot Div., of Beckman Instruments, Inc., 2500 Fullerton, Rd., Fullerton, Calif.*

CIRCLE 147 ON READER-SERVICE CARD

STACKABLE TRIMMER

Two to ten Model 1W-STK WEE potentiometers stack with lead screws available from top. Wirewound ele-

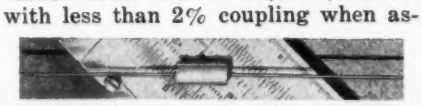


ment with 360° wiper is said to withstand 100G acceleration, 50 G shock and operates from −55° to 140°C rating 1.3 watts at 40°C. Sealable to meet MIL-E-5272A.—*Handley, Inc., 2030 Colorado Ave., Santa Monica, Calif.*

CIRCLE 148 ON READER-SERVICE CARD

MINIATURE INDUCTOR

New addition extends Wee-Ductor values from 0.1 to 56,000 μhenries with less than 2% coupling when as-



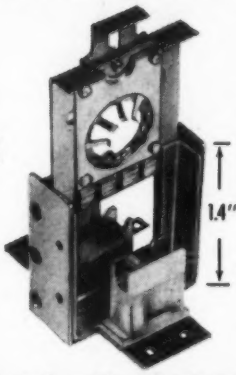
sembled side by side. Meeting MIL-C-15305A requirements, it measures only 0.160" diameter x 0.375" long.—*Essex Electronics, Div. of Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.*

CIRCLE 149 ON READER-SERVICE CARD

a little solution...

TO A BIG PROBLEM*

realize practical UHF lumped constant circuitry with absolute assurance of bandpass stability as tubes are changed.



design permits the miniaturized tube socket to be used to 1000 mc with no resonances over the band.

shown 1/2 actual size in open position.

***Tube Socket for GL-6299 Planar Triode**

Problems of poor grounding and high contact inductance which seriously limit upper operating frequency are now eliminated as well as the problem of varying circuit values resulting from shift of contacts, circuit parts and poor seating. The tube socket has met and exceeded the following environmental tests:

Vibration: 10-55 csp 1/64" excursion; Altitude 10,000 ft. (operative) and 40,000 (inoperative); Drop Test: 2 ft. (equipment units); Bounce Test: 5g for 3 hrs. (equipment units); Humidity: per MIL STD 169. Other applicable Mil Specs met by the tube socket are: MIL.STD 170, MIL.E-16400 and MIL E-5400. The price of the XV-100/6299 ranges from $25 to $14, depending upon quantity. Write for More Information.

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CIRCLE 71 ON READER-SERVICE CARD

Robot Check-out Technician

A new preflight checkout system which operates over airline distances of 2 miles to perform a complete electronic physical checkup on the Mach 2 fighter-bomber, has been developed by Republic Aviation Corporation, Farmingdale, L. I., N. Y. Designated the RADFAC (Radiating Facility for Aircraft Flight Line Testing), it responds to a remote signal from the pilot or crew chief by running an electronic check over the jet's communication, IFF and navigation systems. It advises the pilot verbally or by tone signals if the plane circuits are in good working order; if anything is amiss it pinpoints the trouble.

ELECTRONIC CHECKOUT via Radio-Control is function of RADFAC.

The checkout sequence is a programmed series which eliminates the possibility of human error through forgetfulness. Under "scramble" conditions, the checkout can be initiated by the pilot seated in the cockpit. If the RADFAC should break down, a signal makes this known to the crew chief who can complete the test sequence manually.

The system is housed in a trailer which is complete with self-contained power supply, antenna and obstruction lights. Although it weighs 3,500 lbs, it replaces a large array of mobile and portable equipment which must be transported to or aboard military aircraft under previous check-out systems. The RADFAC can be transported by air and can be installed in a protected location remote from the flight line.

FOR MORE INFORMATION CIRCLE 150 ON READER-SERVICE CARD

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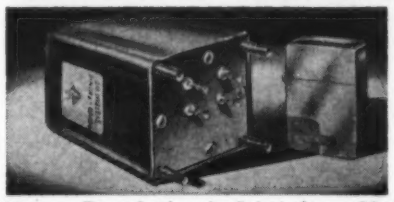
Your assistance in ensuring the widest readership of MILITARY SYSTEMS DESIGN among your fellow-workers in design engineering is requested. After filling out your reader service card may we suggest that you write the names of others in your department who should see this copy on a routing slip and clip it to the front cover of this copy for local routing. This is asked because requests for places on the MSD subscription list far exceed the 35,000 copies printed each issue. Thanks for your help.

TRANSISTORIZED REGULATOR

New transistorized voltage regulator is available in outputs from 35 to 150 v dc at load currents up to



500 ma. Regulation is 0.1% for ±20% variation in input and for zero to full load. Meets MIL-E-5272.—*Powertronic Systems, Inc., 10 Pine Court, New Rochelle, N. Y.*

CIRCLE 235 ON READER-SERVICE CARD

THICK-CHASSIS TERMINAL

Type RFT-SM-2 TUR-C4 "Press-Fit" terminal with longer Teflon body accomplishes secure mountings

in chassis up to 0.125" thick using one-piece construction to eliminate nuts, washers and other hardware.—*Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.*

CIRCLE 236 ON READER-SERVICE CARD

Sturtevant
TORQUE TESTING FIXTURE

FOR TESTING Screws, thread-cutting and thread-forming screws—all types of threaded fasteners; threaded parts and threaded connections.

FOR MANUFACTURERS
DESIGNERS
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TOOL ENGINEERS
LABORATORIES and for
PRODUCT CONTROL
in assembly.

Capacities: (0-200 in. lbs.) or (0-150 ft. lbs.)

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NO. 1 OF A SERIES

ASTRON SOLID TANTALUM CAPACITORS

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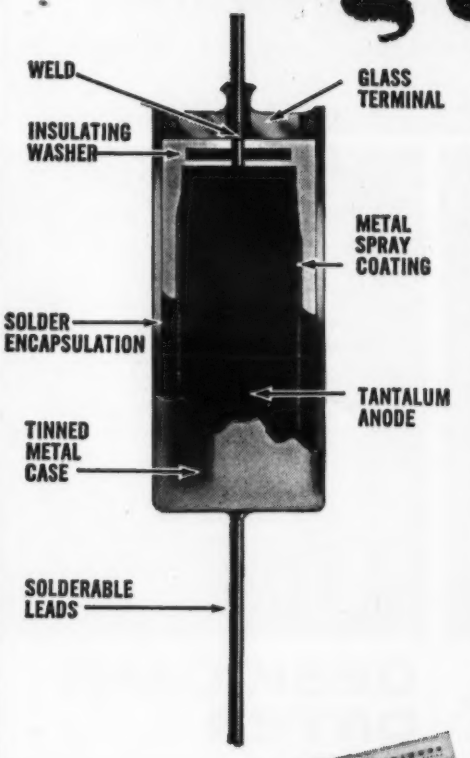
WITHSTAND vibration TO 2000 CYCLES AND 35 G'S.

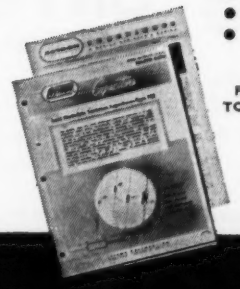


In the construction of the Astron Tantalum Solid Electrolyte Capacitor, the tantalum anode is firmly embedded in solder and solidly fixed in the case. There are no external welds, and the tinned leads can be bent adjacent to the case.

Production capacitors are regularly tested in accordance with MIL-STD-202A, Method 204, test condition B, to 2000 cycles and 15 g's.

Astron Solid Tantalum Capacitors have withstood 200 g acceleration and 150 g shock tests.

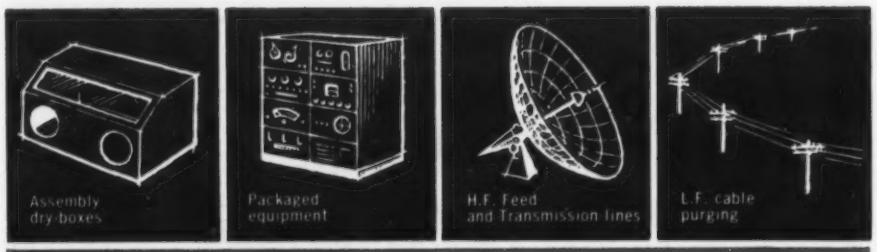
- 125°C operation.
- Rugged construction.
- Capacitance stability.
- Subminiature.
- Dry, solid construction.
- Meets MIL specifications.



FOR COMPLETE INFORMATION WRITE TODAY FOR BULLETIN E-675A AND FOR ASTRON'S DESIGN ENGINEER PUBLICATION, TECHNIQUES, VOL. 59, NO. 2

ASTRON

CIRCLE 73 ON READER-SERVICE CARD



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Wherever you need a supply of extremely dry air you can eliminate the expense and bother of inert gas or replaceable cartridge type dryers—and still achieve a lower dewpoint.

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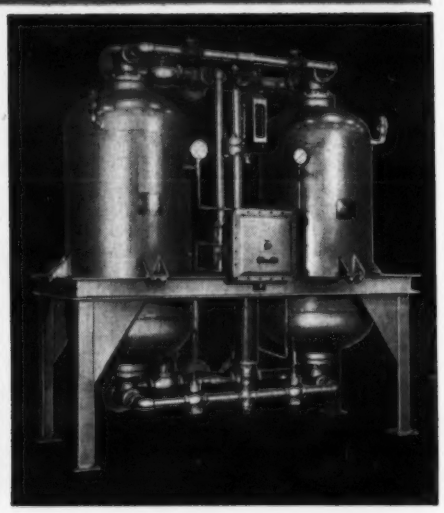
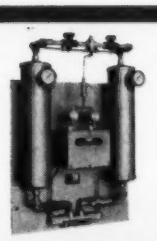


Heat-Les DESICCANT DRYER

Super-dry air—automatically—at low cost—right from your plant air supply. The Heat-Les dryer has no electrical or steam heaters—no maintenance—no expense! Produces completely dry air without raising temperature. Proved in hundreds of commercial and military installations.

- Dewpoints to —200°F
- No bothersome heaters for reactivation
- Low initial cost. Low operating cost.

Heat-Les Dryers Are Available For All Capacities And Pressures.



- AVAILABLE FOR USE WITH PLANT AIR, OR IN A COMPLETE, READY-TO-OPERATE UNITIZED SYSTEM INCLUDING COMPRESSOR, ACCUMULATOR AND ALL CONTROLS..

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World leader in dry gas/air systems

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Thermocouples and Thermowells

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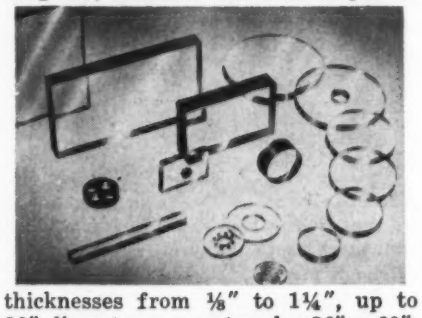
CIRCLE 74 ON READER-SERVICE CARD

HEAT RESISTANT GLASS

New heat-resistant flat borosilicate glass is now available in square, rectangular, circular and odd shapes in

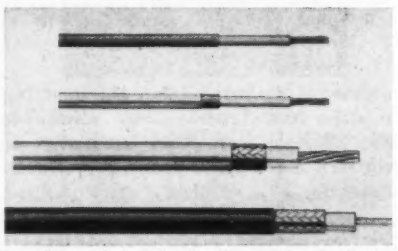


thicknesses from ⅛" to 1¼", up to 30" diameters or rectangles 26" x 60". Catalog on request.—*Kaufman Glass Co., 1209 French St., Wilmington, Del.*

CIRCLE 151 ON READER-SERVICE CARD

CRITICAL MILSPEC CABLES

Single-shield Solid Dielectric (Type SSD) minimum-loss cables, Single-shield Semi-solid Dielectric (Type SSDS) cables having higher velocity and lower capacitance than SSD,

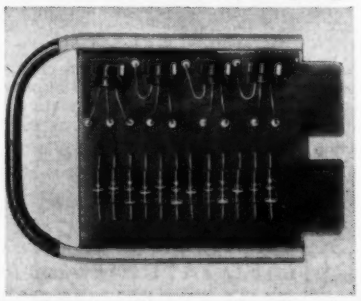


Double-shielded Double-jacketed (Type JEL) Triaxial cable for stringent shielding applications, and Single-Shield Solid-dielectric Large Diameter (Type SSDL) for transmission at high power levels are new types offered to meet increasingly critical RF requirements and Military Specifications. Data literature on request.—*Times Wire and Cable Co., Inc., Wallingford, Conn.*

CIRCLE 152 ON READER-SERVICE CARD

INDICATOR AMPLIFIER

Series M Digital Amplifier Module Model LA-101 contains 4 driver circuits each driving one neon indicator lamp when actuated by flipflop or



gate. Input voltage under 2 v turns indicator ON; input over 8 v turns indicator OFF.—*Computer Control Co., Inc., 983 Concord St., Framingham, Mass.*

CIRCLE 153 ON READER-SERVICE CARD

Magnetic Multiplication

The magnetic multiplier is a miniaturized magnetic modulator designed to deliver an anlog output voltage which is the continuous product of two variable input voltages. One of these is an excitation voltage which varies over a predetermined range; in this case, 0-1 v rms 400 cps. The other signal is a dc current which varies between 0 and 400 μa.

The output voltage is 400 cps ac, and is always either in phase or 180° out of phase with the variable excitation, i.e., in phase when the variable amplitude dc signal is positive and 180° out of phase when the dc signal is negative. The general schematic of the multiplier circuit is shown in Fig. 1.

The relationship between the variable amplitude ac supply signal voltage E_s, variable dc control signal E_c, and the sinusoidal alternating load voltage E_L, is denoted by the expression:

$$E_L = K \times E_s \times E_c \text{ where K is a constant.}$$

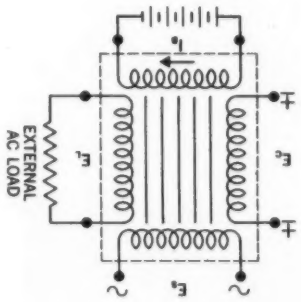
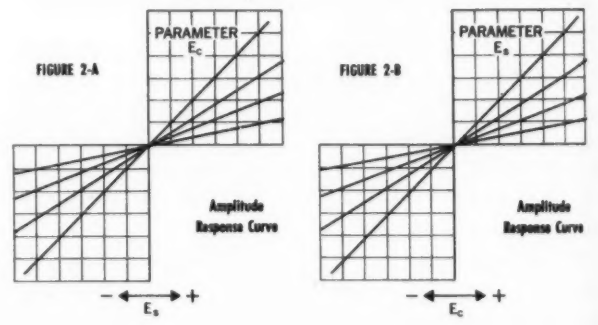


FIG. 1. MAGNETIC AMPLIFIER, Schematic Diagram.

FIG. 2. LINEAR TRANSFER RESPONSE curves.



This expression which defines the fundamental principle of the 4-quadrant Magnetic Multiplying Modulator, is also illustrated by the linear transfer response curve families shown in Figs. 2A and 2B. With linearity of response curves held to within approximately 1 to 2% of theoretical straight lines, product accuracy of the fundamental equation will be within 2-5% of the theoretical.

Salient specifications of the Model MCM, 515-1 are: Variable E_c, 0 to 1 v rms 400 cps; control signal winding dc resistance, 2650 ohms; Input dc signal range, 0 to ±400 μa; AM ac output range, 0 to 0.9 v rms @ 400 cps, phase reversing; Null drift (in terms of input signal), ±2 μa over the range of —65°C to 135°C.—(*From 6-page brochure* 102, *General Magnetics, Inc.*, 135 *Bloomfield Ave., Bloomfield, N. J.*)

FOR THIS LITERATURE CIRCLE 154 ON READER-SERVICE CARD

Permanent Magnet Focusing in 1 KW Gridded TWT Amplifier

Combination of permanent magnet focusing with a gridded gun for easy modulation control has resulted in a traveling wave amplifier exhibiting full 1 kw power output characteristics with low power consumption, according to the developers, Hughes Products Group, Electron Tube Div., Hughes Aircraft Co., International Airport Station, Los Angeles 45, Calif.

Although traveling wave tubes with gridded guns have previously been available with solenoid focusing, permanent magnet focusing in the new tube, designated MAS-1E, provides advantages of lighter weight, no solenoid power supply needed, low heat generation and improved reliability.

FIG. 1. **GRIDDED** High Power TW Tube also contains permanent magnets for focusing.

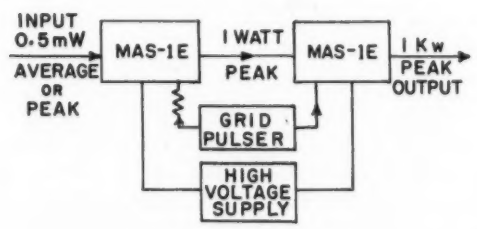


FIG. 2. **CASCADE** operation of two MAS-IE Tubes gives 1 KW output from 0.5mw drive.

The MAS-1E is said to have the following advantages over previously available non-gridded TW structures: (1) Pulse voltage requirements reduced by a factor of 20; (2) Very fast turn-on beam and fast pulse rise-time; (3) Modulation power required for gridded tube is only about 2% or less of that required for cathode modulation. This is seen from the fact that the modulator supplies a 325v pulse into a 15$\mu\mu$f load (intercepted grid current is approximately 0.1 amp whereas the modulator for cathode modulation must supply a 7100 v pulse into a 30-50$\mu\mu$f load (with a beam current of 1.1 amp during the load).

The Hughes MAS-1E is primarily designed as a final output tube. However, if more power is required it can be used to drive other high powered TW tubes or klystrons. At full 1 KW output it requires an input of only 0.5 watt, or by using two tubes in cascade (Fig. 2) full output can be obtained with less than 0.5 mw drive.

FOR MORE INFORMATION CIRCLE 155 ON READER-SERVICE CARD

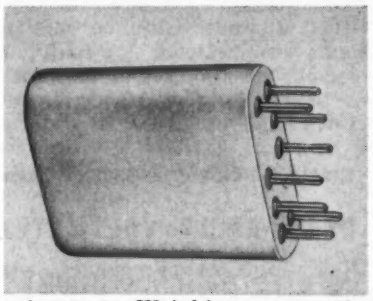
BUSHIPS TUBE FITTINGS

Hydraulic and air tube Ferulok LHBU union fittings meeting MIL-F-21467 are available in sizes from ⅛" to 2" including 16 combination or reducing sizes not previously available.—*Parker Fittings & Hose Div., Parker-Hannifin Corp.*, 17325 *Euclid Ave., Cleveland* 12, *Ohio.*

CIRCLE 156 ON READER-SERVICE CARD

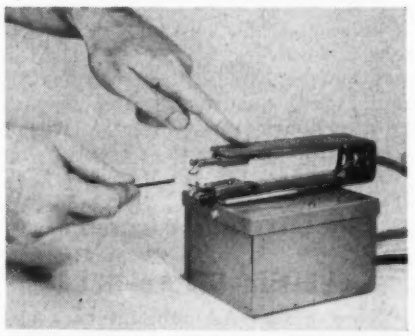
SUB-MINIATURE RELAY

New 2PDT Crystal-case Relay rotary principle with bifurcated contract structure, said to improve reliability and efficiency in dry circuit applications and to exceed MIL-Spec



requirements. Weighing approx ½ oz, it is designed for a life of over 100,000 operations continuous duty in the −65° to 125°C range.—*Union Switch & Signal Div., Westinghouse Air Brake., Swissvale, Pittsburgh* 18, *Pa.*

CIRCLE 157 ON READER-SERVICE CARD



THERMAL WIRE STRIPPER

New Rugged High-Speed Industrial Model For Teflon And Other Plastic Insulation

Completely eliminates cut or nicked wire strands since no blades are used. Has High-Low heat control to strip both Teflon and lower-melting plastics. Strip any size wire without adjustment. Designed for high-speed production use. Use either as bench or hand tool. Simple to operate. Insert wire, clamp, then pull. Has adjustable stripping length stop. Sturdy long-life heating elements are easily replaceable. Heavy-duty power supply.

Price $44.50 FOB Altadena, Calif.

Western Electronic Products Co.
655 Colman Street, Altadena, California

CIRCLE 75 ON READER-SERVICE CARD

$E_b = 10 Kv$

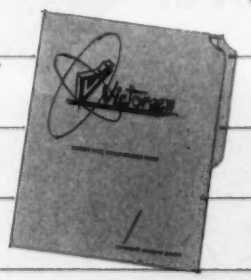
ACTUAL SIZE
VICTOREEN 7234
(PENTODE)

CONSIDER USE IN HIGH VOLTAGE REGULATOR CIRCUITS OR HIGH VOLTAGE AMPLIFIERS.

CHARACTERISTICS	7234 PENTODE	6842 PENTODE	7683 PENTODE
E_f	6.3V	6.3V	6.3V
I_f	150ma	150ma	150ma
E_b MAX	10,000V	4,000V	1,000V
I_p MAX	5ma	10ma	20ma
G_m	3800	2500	5000
R_p	1 Megohm	930Kohm	30Kohm
SIZE	T-6½	T-5½	T-6½

A-1483A

WRITE FOR TECHNICAL INFORMATION PACKAGE.



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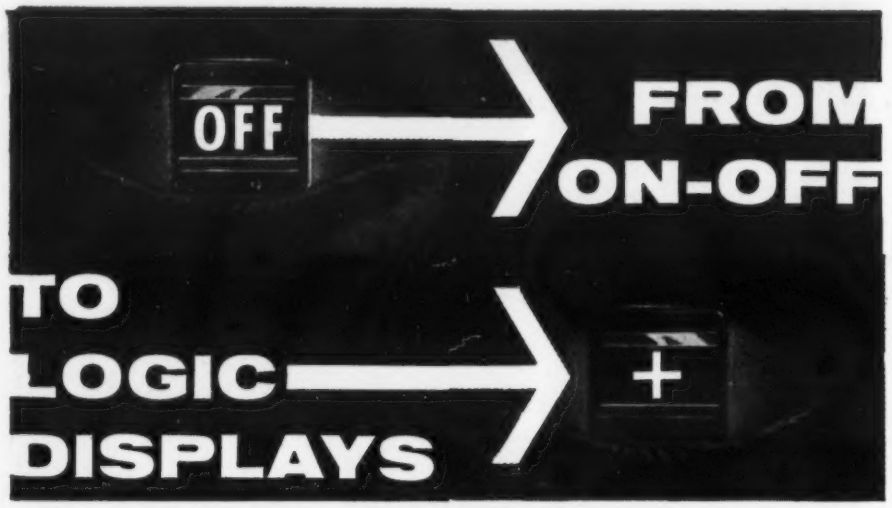
CIRCLE 76 ON READER-SERVICE CARD

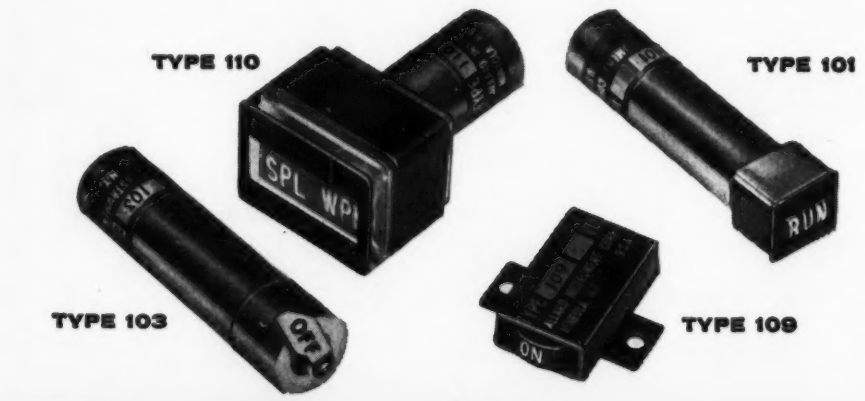


ALLARD ELECTROMAGNETIC INDICATORS GIVE YOU POSITIVE SIGNALING IN MITE-SIZE PACKAGES

Designed expressly for compact instruments and control panels, Allard miniature indicators meet the most critical requirements for small size, low power drain, positive performance in extreme environments.

Unlike lamp signals they are not subject to burnout, provide high readability even in strong incident light. What's more—Allard indicators offer unparalleled application flexibility, permit complex indications without the need for relays or grouping of multiple units.

Typical of the wide range of Allard signals available for demanding airborne or ground service are those shown here. All can be supplied to meet most specifications for display, operating voltage and mounting, in models for either military or industrial applications.



TYPE 101: TYPE 103: TYPE 109: TYPE 110:

If your design demands visible signals, you'll want to have full technical and application information on the complete line of Allard indicators.

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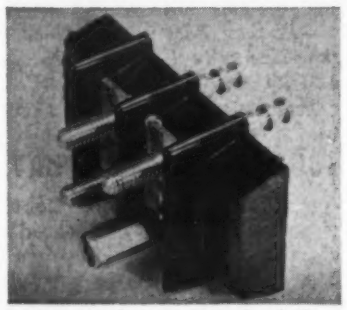
CIRCLE 77 ON READER-SERVICE CARD

TERMINAL CHOICE

Wide choice of terminal arrangements now available include: Regular screw type; screw type on top, feed-thru turret terminals on bottom;



threaded stud on top, feed-thru on bottom; threaded stud on top only; Solder terminals on top only; and taper-pin terminals. Detailed Literature available.—*Kulka Electric Corp., 633-643 So. Fulton Ave., Mount Vernon, N. Y.*

CIRCLE 158 ON READER-SERVICE CARD

PHASE-ANGLE VOLTMETER

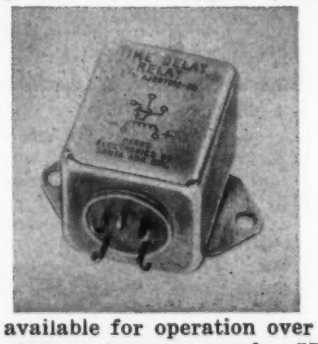
New Multiple Frequency phase angle voltmeter, Model VM-204, accommodates signals at three specified frequencies in the 60-4500 cps range,

for ground checkout of missile synchro, resolver, transducer and potentiometer loops. Nulls, phase angles, and total, quadrature and in-phase voltages are read directly without computations.—*North Atlantic Industries, Inc., 603 W. Main St., Westbury, N. Y.*

CIRCLE 159 ON READER-SERVICE CARD

SUB-MIN DELAY RELAY

New Series AJ subminiature electronic Time Delay Relay designed primarily for control of conventional multipolar relays in support system is

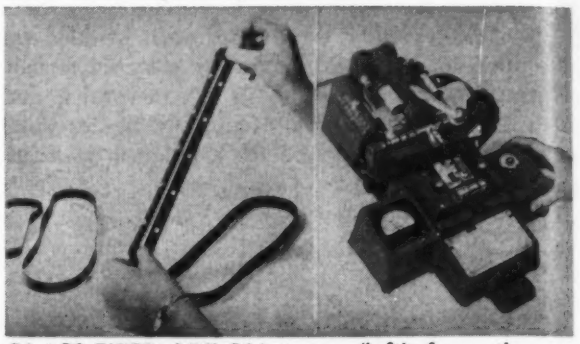


now available for operation over ambient temperature range of —55° to 125°C and from 20 to 32 v dc. Delays range from 50 milliseconds to 60 seconds.—*Parko Electronics Co., 2539 S. LaCienga Blvd., Los Angeles 34, Calif.*

CIRCLE 160 ON READER-SERVICE CARD

Glass-Fibre Tape Splicer

Manufacture of new vertical-scale aircraft instruments recently developed by the Bendix-Eclipse Pioneer Div., in connection with the Wright Air Development center, required a machine that would (1) uniformly cut the exact spot on the nylon-coated glass-fibre altimeter scale tape, (2) seal the ends in precise lateral alignment, (3) produce minimum ridge at the splice, and (4) meet rigid length tolerances.



GLASS-FIBER NYLON tapes (left) form the accurately indexed scales of the new Bendix vertical-scale aircraft instruments. Presto-Splicer (right) joins ends of tape loops to provide smooth-indexing to 0.001" tolerance.

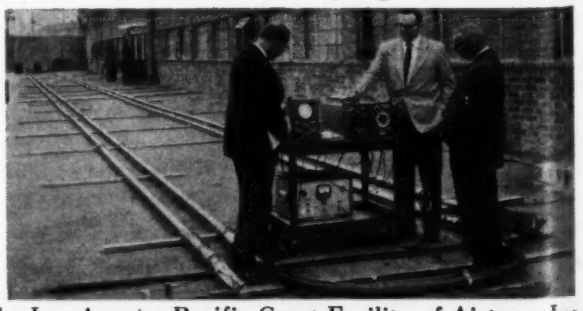
Design of the Bendix instrument involves two endless tapes, one inside the other. The tough nylon surface of the tape provides high resistance to wear and the numerals are covered by a layer of clear nylon for added protection. The inner tape is longer than the outer by several sprocket holes. This difference in length, combined with its numerical arrangement, causes an indexing action to occur.

In meeting the requirement for precision and reliability, and working closely with the maker of the tape, General Plastics Corp.; the Prestoseal Mfg. Corp., 37-25 33rd St., Long Island City 1, N. Y., adapted its series 300 Presto-Splicer to form a 0.040" over-lap splice at a 15° diagonal cut, compressed flat on the sprocket drive and squeezed to within 0.001" of thickness of a single layer of tape. Heat and pressure are the only adhesives used in this highly reliable and rapid technique for splicing glass-fibre tapes.

FOR MORE INFORMATION ON TAPE SPLICER CIRCLE 161 ON READER-SERVICE CARD

Low-Loss Waveguide System

An unusually long run (2200 ft) of X-band waveguide to be installed at the Vandenberg Air Force missile center is shown undergoing final checkout at



the Los Angeles Pacific Coast Facility of Airtron, Inc., a division of Litton Industries.

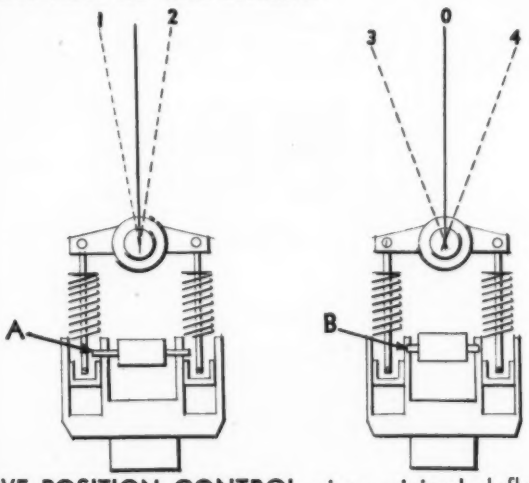
Composed of sections of 3" copper tubing, flexible

rubber covered tubing and mode absorbers, it is said to have less than 10 db attenuation per 1000 ft as compared to 50 db for conventional wave guide. The simplicity of the design is credited to a special transition which converts from standard waveguide to the TE/01 mode in the circular waveguide. The same type of transition reconverts the wave at the terminal. This is said to be the first of a number of similar custom installations to be assigned to Airtron.

FOR MORE INFORMATION CIRCLE 162 ON READER-SERVICE CARD

Hot-Gas Servo Controls Missile

A discontinuous, on-off type actuator control for use with missiles and drones using solid propellant fuel and designed to provide reliable actuation up to 10 minutes of flight has been announced by the Light Military Electronic Dept., General Electric Co. Called the Flicker Hot Gas Servo, the system consists of one or more hot gas generators, a turbine alternator, four control actuator assemblies, and a solenoid-operated control valve for each actuator.



FIVE POSITION CONTROL gives minimal deflection to control surfaces when solenoid stops are extended as in (A), maximum deflection when stops are retracted as in (B).

Each control actuator consists of a pair of pistons attached to opposite ends of a rocker arm connected to the control fin shaft (See Figure). The system package can be located in the neckdown nozzle area of the main engine.

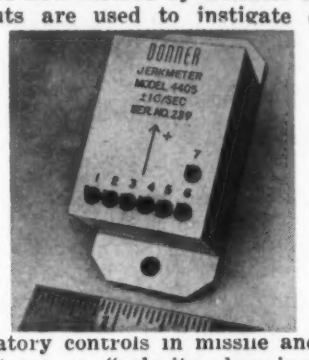
Two-position, three-position and five-position control operational methods are possible with the system. In the two-position type the fins are actuated either to full positive or full negative torque. If three positions are used, the fins are operated positive or negative upon signal but are returned to the zero position when no signal exists. In five position operation, both maximum and moderate deflection can be given in either positive or negative direction.

Hot gases retained under pressure in the generator provide extended power control after propellant is completely burned. Standby life of at least five years in storage while ready for instant use is claimed for the system, due to the simplicity of the design and reliability of the poppet valve controls. (*From* 4-*page Bulletin GEA-59APJ-59, Light Military Electronics Dept., General Electric Co.,* 600 *Main St., Johnson City, N. Y.*)

FOR THIS LITERATURE CIRCLE 163 ON READER-SERVICE CARD

PRECISION JERKMETER

Rate of change of acceleration (Jerk) is measured to an accuracy of 0.1% by linear and angular Jerkmeters now offered by Donner. Their outputs are used to instigate com-



pensatory controls in missile and jet flight or as "velocity damping" to achieve constant acceleration. An acceleration output voltage is also available. Jerk ranges of ±0.5 to ±20.0 G/sec full scale output (±7.5 v dc) are available.—*Donner Scientific Co., Concord, Calif.*

CIRCLE 164 ON READER-SERVICE CARD

PRODUCTION CENTRIFUGE

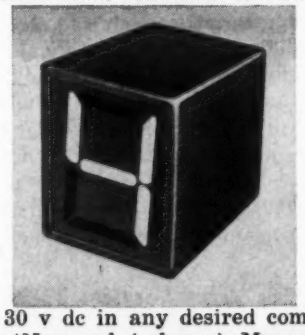
Fast testing of components at preset accuracies better than 1% rpm, new G-RATER operates up to 100 G acceleration force in a number of

speed ranges. Two matched objects larger than 3" cube and 5-lb weight can be tested in 3 axes on the standard boom. 8 slip rings, each with 2-amp capacity, are standard.—*The Gyrex Corp.,* 3003 *Pennsylvania Ave., Santa Monica, Calif.*

CIRCLE 165 ON READER-SERVICE CARD

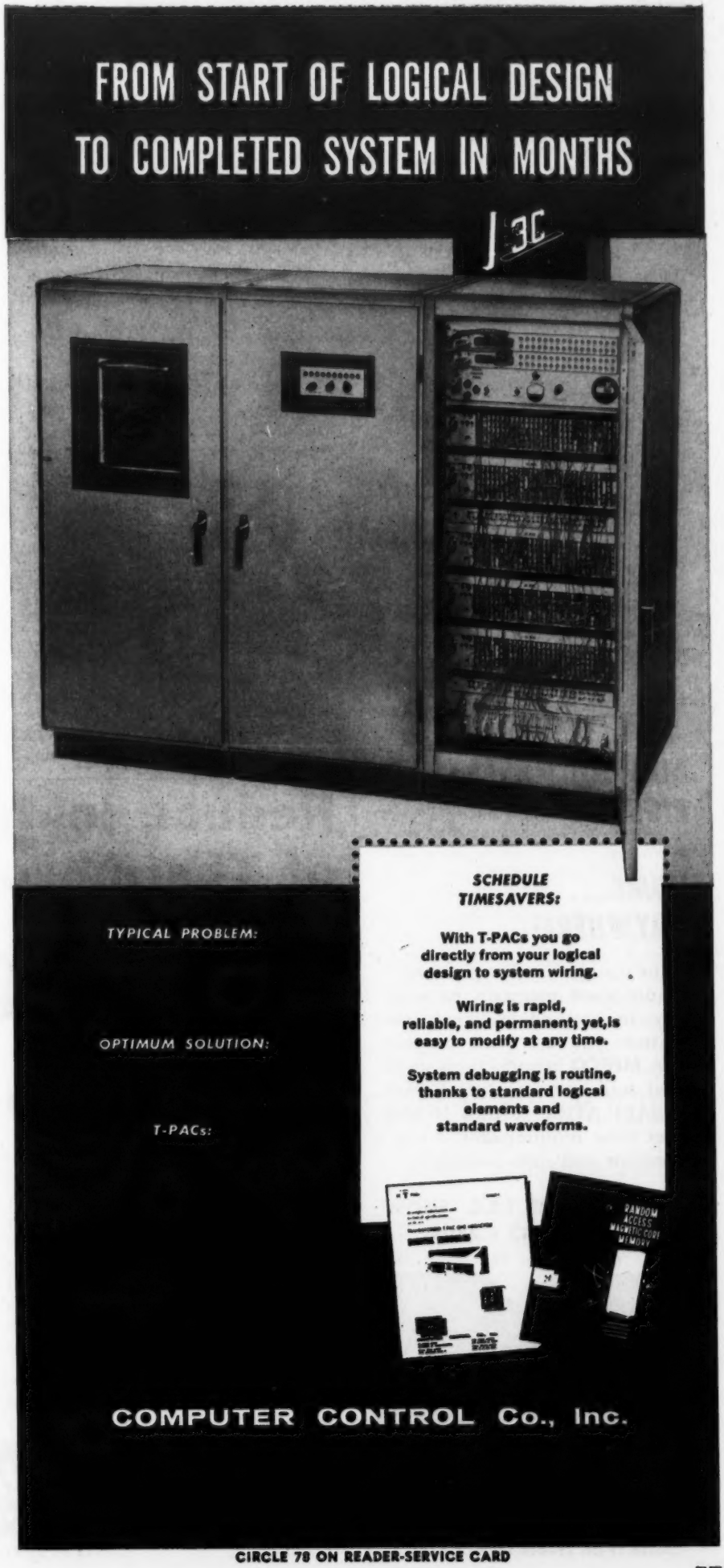
DIGITAL INDICATOR

New electromagnetic numerical readout module utilizes seven miniature indicating segments operated on



1 to 30 v dc in any desired combination. (Numeral 4 shown) Momentary or latching types available, can be mounted in close order.—*Allard Instrument Corp.,* 146 *E. 2nd St., Mineola, L. I., N. Y.*

CIRCLE 166 ON READER-SERVICE CARD



CIRCLE 78 ON READER-SERVICE CARD

MEPCO RESISTORS
RIGHT
AT
HOME...
ANYWHERE!

If the equipment that you manufacture must maintain its accuracy in any environment, the resistors you use must be reliable. **MEPCO** manufactures seven axial lead styles to MIL-R-9444 (USAF) AFRT 10 thru 16 that meet these requirements.
Complete test data available.

SEE US AT THE I.R.E. SHOW BOOTH 2802 - 2804.

MEPCO INC.
MORRISTOWN, N. J.

CIRCLE 79 ON READER-SERVICE CARD

HIGH-G ACCELEROMETER

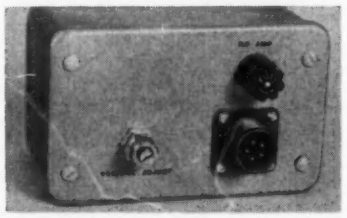
New potentiometric Model 400 acceleration transducer features a broad band-width sensor, 0-10 G, flat to 50

cps. Dimensions 1-⅛" square by 2¼" long; weight is less than 5 oz.—*White Avionics Corp., Terminal Rd., Plainview, L. I., N. Y.*

CIRCLE 167 ON READER-SERVICE CARD

DC-DC VOLTAGE REGULATORS

Miniaturized transistorized voltage regulator provides accurately regulated dc voltages of 6 to 35 v dc from

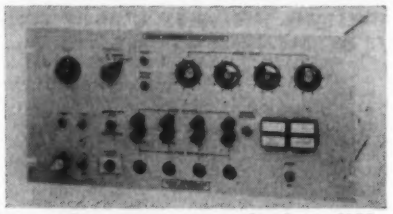


input voltages ranging from 24 to 45 dc, allowing economical use of regulated voltages only at points where required.—*Valor Instruments, Inc.*, 13214 *Crenshaw Blvd., Gardena, Calif.*

CIRCLE 168 ON READER-SERVICE CARD

4-PROGRAM PULSER

New Programmed Pulse Generator Series (Model II-507B shown) features modular construction, delivers

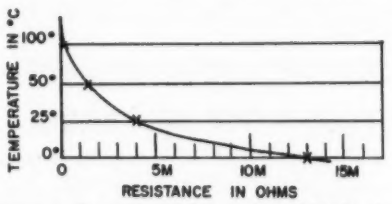


four pulse programs pulsed at different PRF's to two signal outputs with sync pulses.—*Inconix, Inc.*, 945 *Industrial Ave., Palo Alto, Calif.*

CIRCLE 169 ON READER-SERVICE CARD

DISC THERMISTOR

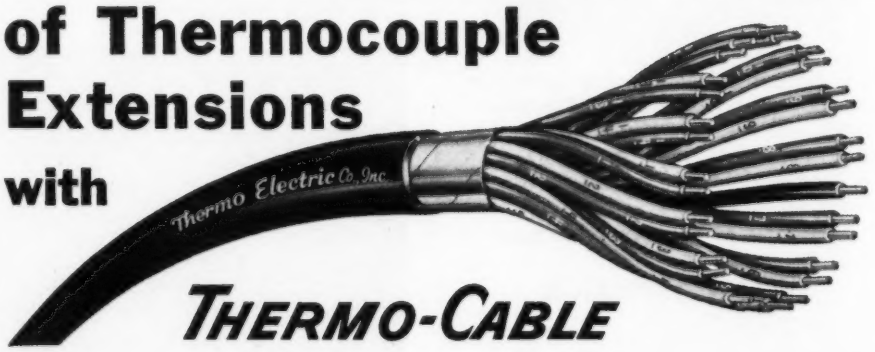
Available for first time from stock, VECO 34D4 disc thermistor (7/16" diameter wafer) conforms within ±5% to the resistance/temperature



curve shown making it ideal for temperature compensation or measurement.—*Victory Eng. Corp.*, 534 *Springfield Rd., Union, N. J.*

CIRCLE 170 ON READER-SERVICE CARD

Reduce Installation Costs of Thermocouple Extensions with THERMO-CABLE



You can now install 6 to 56 pairs of thermocouple leads at one time with "Thermo-Cable," T-E's new multi-conductor extension cable. Installed in conduit, "Thermo-Cable" reduces costs by eliminating the need to pull individual conductors—and permits the use of smaller conduit for the same number of leads. "Thermo-Cable" can also be installed without conduit, in open troughs or in raceways.

"Thermo-Cable's" smooth, polyvinyl chloride outer jacket resists moisture, heat, abrasion and chemical action—and slips easily through conduit. ISA color coded, individual conductors are also insulated in hi-temp (221°F.) polyvinyl chloride—and the conductor bundle is wrapped in aluminum-backed Mylar tape. Pairs are numbered alike and lie next to each other. "Thermo-Cable" is available in 6, 14, 18, 25, 39 or 56 pairs and comes in all standard thermocouple materials.

Write For Wire Section 33-9

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada:
THERMO ELECTRIC (Canada) LTD.,
Brampton, Ont.

CIRCLE 80 ON READER-SERVICE CARD

R-I/F-I Meter Uses APR-9 Tuners

A laboratory precision portable and mobile radio-interference and field-intensity measuring equipment designed to work with Government supplied APR-9 RF Tuners is now available. This equipment, designated NM-60A, and originally developed for government use as the AN/URM-42 government by the Stoddart Aircraft Radio Company, Inc., can now be utilized by government services and contractors who have, or can obtain custody of, these tuners.

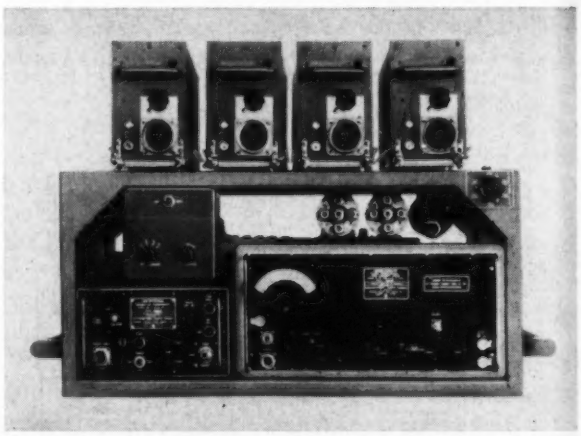


FIG. 1. FOUR APR-9 Tuners used with new Field intensity and interference meter console save money, conserve space in aircraft.

APR-9 units which are supplied by customers will be modified by Stoddart to operate from a 110 v ac, 50 to 400 cps supply. The NM-60A Console (Fig. 1) electrically selects the desired tuner, adding calibrated RF Turret Attenuation before the RF tuner to prevent overload. Electrical coaxial switching of input and output circuits and of high voltage supply to the tuner selected, while keeping all tuner heater circuits alive, is accomplished by the single Master Selector Switch. Electrical tuning of each RF tuner can be controlled for rapid or slow automatic scanning, or disengaged to permit manual precise tuning.

When the NM-60A Console is used in an aircraft equipped with APR-9 Receiving Equipment, the tuners may be switched into the NM-60A Measuring Equipment without requiring installation of the NM-60A APR-9 Special Power Supply.

The NM-60A Console System for making site surveys, or investigating, monitoring, analyzing and accurately measuring radio interference and field intensities, consists of the NM-60A Console, a 1-kw engine-

generator, and an accessory rack, all mounted in a Volkswagen Micro-Bus with sliding top (Fig. 2)

This System, with suitable horn or broad-band antennas, can be used to determine the electronic compatibility of weapons and missiles firing and guidance systems; checking telemetering systems for spurious, anharmonic and harmonic radiations; or checking entire military facilities for unwanted radiation from electrical appliances, ignition systems, machinery,

FIG. 2. SITES ARE SURVEYED and Interference analyzed by new System in V-W Micro-Bus.

communications equipment, Radar, and other radiating equipment in accordance with Military Measurement Specifications. It also serves to measure signal power density in watts per square centimeter, provide wave propagation and antenna pattern analyses, to measure shielding effectiveness of military equipment, and to determine the efficiency of frequency spectrum utilization. (*From 4-page bulletin, "Super High Frequency RI-FI Measuring Equipment," Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.*)

FOR THIS LITERATURE CIRCLE 171 ON READER-SERVICE CARD

Higher Temperature Thresholds for Microwave Diodes

As a result of improved processing techniques, but at no added cost to the customer, the Sylvania Electric Products, Inc., Woburn, Mass., announced raised temperature ratings of its full line of X- and S-band microwave diodes, from a maximum of 70°C to a new high of 150°C. The diode types affected include:

Micro-Min diodes: IN830, IN830A, IN831, IN831A, IN832, IN833;

Forward-reverse and matched pairs: IN21B, IN21C, IN21D, IN21E, IN21F, IN23B, IN23C, IN23D, IN23E:

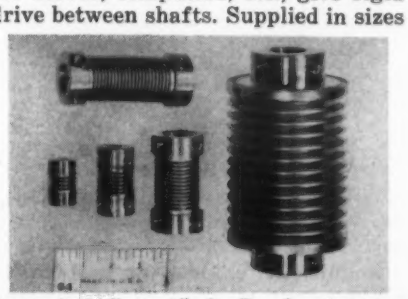
Double ended diodes: IN21WE, IN416B, IN416C, IN416D, IN416E, IN23WE, IN415B, IN415C, IN415D, and IN415E.

In addition to reducing the previous requirement for air cooling equipment, the new high temperature diodes are suited to many commercial applications where ruggedness and price are controlling factors.

FOR MORE INFORMATION CIRCLE 172 ON READER-SERVICE CARD

MINIATURE COUPLINGS

New miniature flexible couplings for servos, computers, etc., give rigid drive between shafts. Supplied in sizes

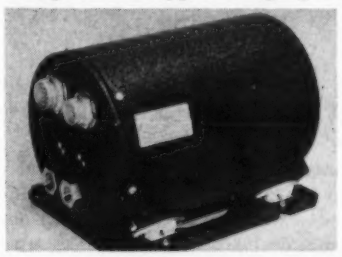


from 0.125" to 1" O. D., for torques from 0.1 in-oz to 250 in-oz, side thrusts from 1 gram at 0.005" offset, and twist angles of less than 0.3° in all sizes. Engineering bulletin available.—*Servometer Corp.*, 222 *Main Ave., Passaic, N. J.*

CIRCLE 173 ON READER-SERVICE CARD

AIRSPEED COMPUTER

Miniature True Airspeed Computer, "Minitas", consisting of sensitive Mach transducer, passive resistance network and follow-up servo conforms to Mil-specs for types ranging from

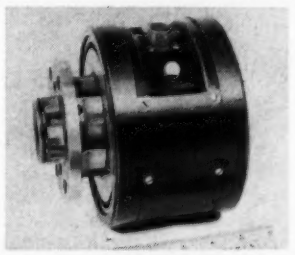


helicopter to missile speeds. Electrical function generator converts total temperature to free airstream temperature and corrects for static pressure defects and installation errors. Servo follow-up provides shaft output to position three output synchros.—*Servomechanisms, Inc.*, 12500 *Aviation Blvd., Hawthorne, Calif.*

CIRCLE 174 ON READER-SERVICE CARD

PROP TORQUE TRANSDUCER

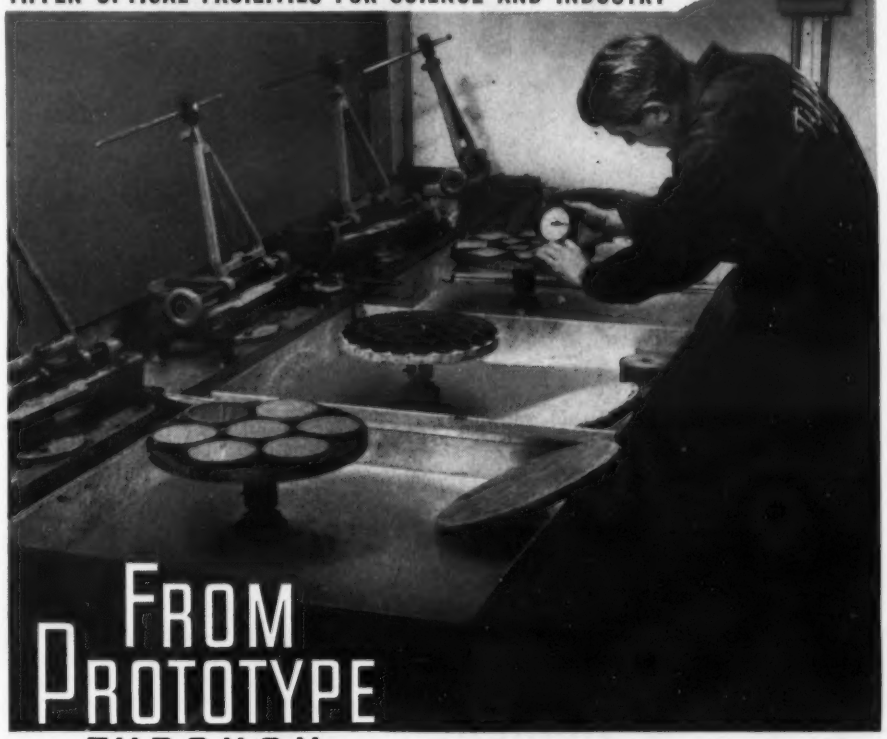
Small aircraft propellor torques are measured directly and in flight by new pickup mounted between engine



and propellor. The pickup allows passage of hydraulic fluid for normal pitch change, is strong enough to withstand gusts and maneuvering loads under maximum power.—*Performance Measurements Co.*, 15301 *W. McNichols, Detroit* 35, *Mich.*

CIRCLE 175 ON READER-SERVICE CARD

TIFFEN OPTICAL·FACILITIES FOR SCIENCE AND INDUSTRY



FROM PROTOTYPE THROUGH PRODUCTION

For over a decade, government agencies, industrial firms and photo studios have turned to TIFFEN for precision optical accessories. Now, TIFFEN offers their specialized knowledge, experience and expanded facilities to all industry employing optics in their product. TIFFEN's major facilities are partially described below:

BLANCHARDS . . . flat grinding to .00005". Diamond wheel shaping to .0001". ***EDGING*** . . . to less than .001", to 20" dia. Bevels and odd shapes ground. ***DRILLING*** . . . dia. .010" to 12", concentric to within .0005", on glass, ceramics, silicon, germanium, etc. ***GRINDING & POLISHING*** . . . 1mm. dia. to 24" dia., within 1/10 wavelength in flatness, under 2 seconds arc in parallel. Roof prisms to 2 seconds of arc accuracy. ***COATING*** . . . high vacuum deposition of all types of material, partial coatings for beam splitters and metallic neutral density filters. ***COLOR LABORATORY*** . . . includes Densichron, Beckman Du Spectrophotometer, Weston Foot Lambert Meter. ***FILTERS*** . . . laminated glass equal in environmental tests to solid glass, with superior color control, resolution to 100 lines per mm. ***MACHINING*** . . . multi-spindle automatic to 4", secondary machines to 10" capacity. ***TOOL ROOM*** . . . 23" swing lathes, grinders, millers. All tools and jigs manufactured internally.

Special problems? Write, call or visit: **TIFFEN OPTICAL CO., 85 Jane St., Roslyn Hgts., L. I., N. Y.**
West Coast Rep.: CRAIG CORP., 3410 So. La Cienega Blvd., Los Angeles 16, Cal.

TIFFEN DELIVERS THE GOODS!

CIRCLE 81 ON READER-SERVICE CARD

HIGH-TEMP TACHOMETER

New miniature high temperature tachometer generator for Jet engines

furnishes 3-phase output with voltage and frequency proportional to rotor velocity.—*Globe Industries, Inc.*, 1784 *Stanley Ave., Dayton* 4, *Ohio.*

CIRCLE 176 ON READER-SERVICE CARD

1000°F PRESSURE SWITCH

New Absolute pressure switches for use near missile engines or where high air friction temperatures eliminate use of standard pressure

switches, are available for use with air, oxygen, steam or hydraulic fluids. Furnished in SPST NO or NC to make or break the circuit at any preset pressure—*Consolidated Controls Corp., Bethel, Conn.*

CIRCLE 177 ON READER-SERVICE CARD

New CPI

PLUG-STAT®

TWO WIRE HERMETICALLY-SEALED

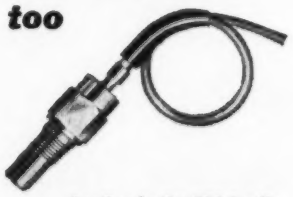
- **NO DRIFT**
- **RUGGED**
- **CLEAN MAKE AND BREAK**

Extreme shock, vibration and other severe environmental conditions will not affect the precise thermal indication of this new CPI hermetically-sealed thermal sensing switch. The new Plug-Stat® is a two-wire, rugged unit with stainless steel welded body and special alloy contacts that make and break *fast* and *clean* at set limits *without drift of calibration.*

This new Plug-Stat® operates accurately in environmental temperatures from minus 65°F. to plus 700°F. and is capable of a 200°F. overshoot from the specified operating temperature. Calibration temperature range from minus 20°F. to plus 700°F. is factory set to a specified tolerance and sealed.

Where you require an extremely sensitive response to high or low temperatures, this new non-drift thermal switch will fit your needs.

Ask about the* SINGLE-WIRE PLUG-STAT,® *too



Another in the CPI family of thermal switches is this single-wire Plug-Stat® for applications where required temperature range limits are minus 20°F. to plus 600°F.

Write now for complete engineering data. Ask for Catalog MS.

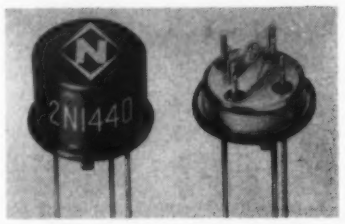
Control **products, inc.**

311 SUSSEX STREET, HARRISON, N. J.

CIRCLE 82 ON READER-SERVICE CARD

SILICON ALLOY TRANSISTORS

Types 2N1440, 2N1441 and 2N1442 silicon alloy transistors for small-signal applications in audio, servo and

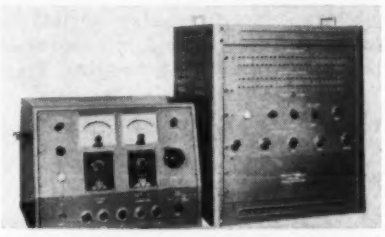


dc amplifiers feature low noise and high gain and maximum current gain and collector cutoff current at 150°C. Are said to exceed requirements of MIL-T-19500A.—*National Semiconductor Corp., Danbury, Conn.*

CIRCLE 178 ON READER-SERVICE CARD

HIGH-POT LIFE TESTER

New Model 8515 Insulation Life Tester (right) makes sequential tests of 50 components for current leakage for periods to 12 hours without manual attention. Components under envir-

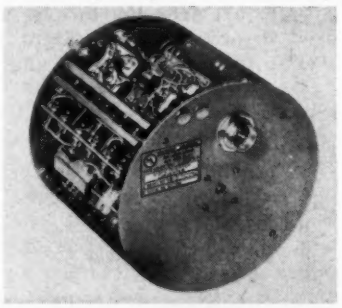


onmental test conditions may be tested up to 20 Kv furnished by Model 8514 HYPOT Set (left), with each component tested for periods up to 15 min. Failure of component may sound alarm, and stop test or continue test on other units while bypassing and indicating failed unit.—*Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.*

CIRCLE 179 ON READER-SERVICE CARD

STATIC INVERTER-CONVERTER

Model SIS-3-71042 is power source operating off self-contained silver cadmium battery to provide 200v/115v 3200 cps 3-phase at 1KVA, 300



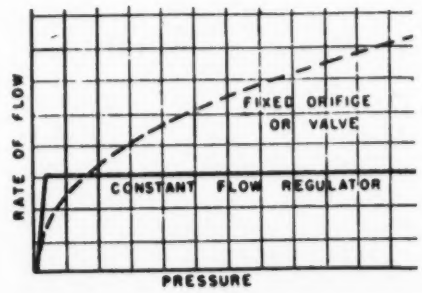
v dc at 0.5 amps and 150 v dc at 1.0 amp. Operates at full output for 4 min, continuously with external cooling, or intermittently with thermal recycle of 1 min ON, 4 min OFF at 50°C. Meets pertinent Milspecs.—*Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.*

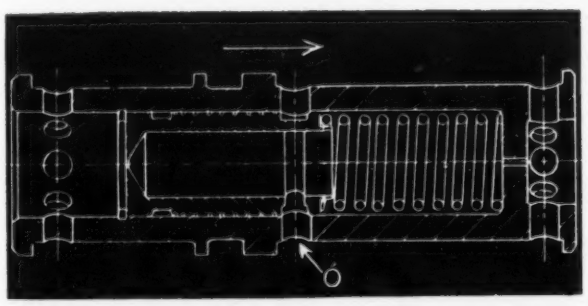
CIRCLE 180 ON READER-SERVICE CARD

Hydraulic Subsystems Regulator

Missile flight control actuators, aircraft landing gear cylinders and fluid motors used in many systems require precise speed-limiting controls. Waterman modular design hydraulic flow regulators reduce the number of flexible and rigid lines from power units to remote areas, by regulating fluid flow to any variety of hydraulic components that require different power levels.

Waterman cartridge style flow regulators are unaffected by changing pressures in the sub-system. The performance chart compares a typical Waterman pressure-compensated flow regulator to a fixed restrictor





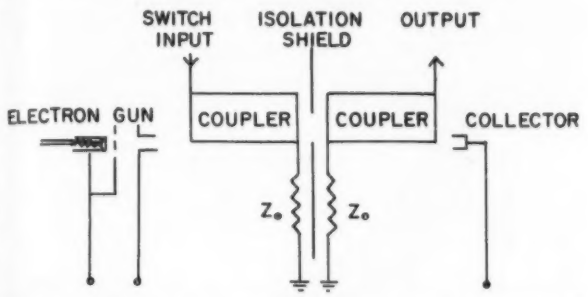
CONSTANT FLOW regulator output is compared with variable flow rate obtained from constant orifice type regulators or valves. Measuring orifice "O" is incorporated in the control piston which operates as a spring-balanced valve, moving to cover more or less of the port with changes in differential pressure across the port.

valve. Note that Waterman regulators incorporate a measuring orifice in the control piston. The piston operates as a spring balanced valve, moving to cover more or less of the port area when there are changes in differential pressure across the orifice. Thus, with an exact balance of forces, a precise rate of flow is maintained through the control orifice and regulator. (*From 4-page Bulletin A-300, Waterman Hydraulics Corp., Box 391, Evanston, Ill.*)

FOR THIS LITERATURE CIRCLE 181 ON READER-SERVICE CARD

Electron Beam Coupling Tube

An electronic component having considerable versatility in circuit application is a new development of Tucor, Inc., of 18 Marshall St., So. Norwalk, Conn. Designated the BEACOTRON, because it employs the principle of BEAm COupling, the operation of the device depends on the switching action of an electron beam joining two otherwise decoupled circuits.



BEACOTRON Tube schematic in which an electron beam provides unity coupling between two otherwise isolated circuits.

As shown above, the device comprises an electron gun, an accelerator anode, and the "control" or "switch" coupler electrode on one side of an isolating shield, in which a single aperture is located. On the other side of the shield the beam passes between the plates of an output coupler to strike the beam collector anode.

When the electron beam is cut off the two coupling circuits are isolated by the internal shield by approximately 60 db. When the beam is turned on, it provides slightly better than unity coupling between the two circuits. This is possible because interaction between the beam and the beam couplers provides a slight gain sufficient to overcome all losses in the device and to provide a small positive gain.

TABLE 1. CHARACTERISTICS OF TWO BEACOTRON TUBE TYPES

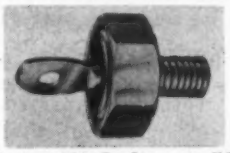
	Type T37LID Switch	Type T37XID Limiter
Frequency	1-2 kmc	8-12 kmc
Incident power (peak)		1 kw max
(Average)	20 watts	1 watt max
Output power (peak)		1 mw max
(Average)	20 watts	1 mw max
Coupling (beam on)	0 db min	0 db max (below 5 mw
(beam off)	—60 db min	incident power)
Noise figure		10 db
Duty cycle	0-100%	
Switching time	1 mμsec	
Beam voltage	400 v	400 v
Beam current	100 ma	1 ma
Weight	6 oz	3 lb
Length	10"	7"

Applications include: Inertialess switching of signals within the period of one milli-microsecond; boardband limiting action with faithful reproduction of all signals below the limit threshold; microwave modulation with smooth reduction of coupling from unity to —50 db.; and as an output leveler for backward wave swept oscillators, in which the output power tends vary with frequency. Units also can be designed for any of the applications mentioned and at any frequency from UHF through the 10 kmc band.

FOR MORE INFORMATION CIRCLE 182 ON READER-SERVICE CARD

HI-POWER ZENER

New 35-watt Zener Diodes are being made by new diffused silicon junction techniques to standard 5% voltage tolerances. Voltages range



from 8.2 to 100 volts at 500 to 50 ma, and applications include high power voltage regulators, limiting and clipping devices, and over-voltage protective devices. Performance graphs and specs in Catalog HPZ-10-59.—*U. S. Semiconductor Products*, 3540 *West Osborn Rd., Phoenix, Ariz.*

CIRCLE 183 ON READER-SERVICE CARD

PRECISION ANGLE COUNTER

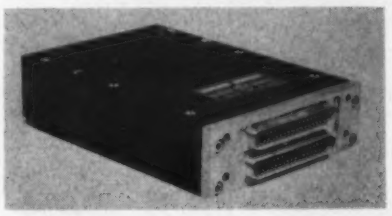
New miniature precision angle counter requiring only ¼" x ⅝" window counts 1°/rev of input shaft.

Standard 3-digit model counts 000° to 359°; can be adapted to 4-digit models, to cycle on other counts and to register tenths of degrees or angular mils. Speeds to 500 counts/sec intermittent over —55° to 125°C ambients.—*Mast Development Co.*, 2212 *E. 12th St., Davenport, Ia.*

CIRCLE 184 ON READER-SERVICE CARD

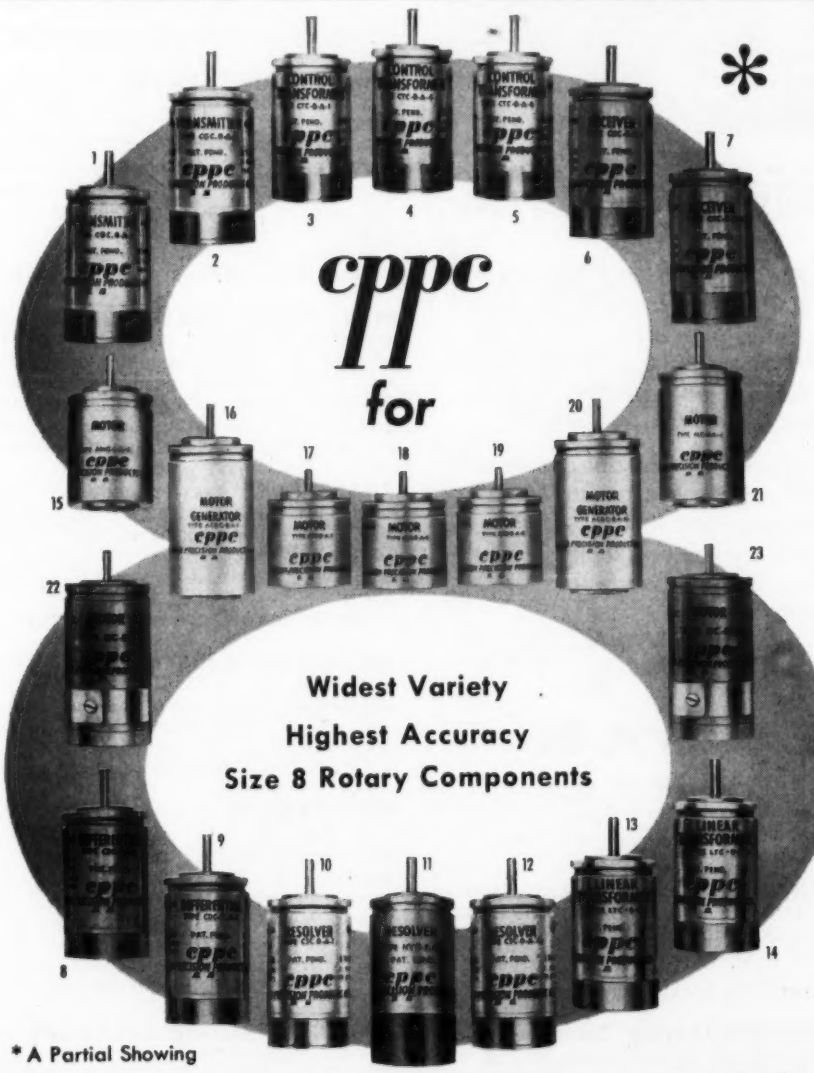
SOLID STATE COMMUTATOR

New dual pole 30-channel nonshorting IRIG standard telemetering commutators are available from stock in 1 fps and 10 fps sampling rates.



All-silicon elements operate into standard subcarrier oscillator with input impedance of ½ megohm; input signal range is 0 to +4 v.—*General Devices, Inc., Dept AE, Box 253, Princeton, N. J.*

CIRCLE 185 ON READER-SERVICE CARD



* A Partial Showing

Clifton Precision's size 8 rotary components have been tried and proven by customers over the past 4 years. More than 50,000 have been shipped. These are the most accurate and best tested (because they are use tested) size 8 rotary components on the market today.

1. Torque transmitter (26v. input) 2. Torque transmitter (115v. input) 3. Control transformer (lo Z) 4. Control transformer (hi Z) 5. Control transformer (very hi Z) 6. Torque receiver (26v. input) 7. Torque receiver (115v. input) 8. Torque differential (lo Z) 9. Torque differential (hi Z) 10. Electrical resolver (.5 t.r.) 11. Precision computing resolver (feedback winding) 12. Electrical resolver (1 t.r.) 13. Linear transformer (115v. input) 14. Linear transformer (26v. input) 15. Servo motor (1" length, .40 in-oz stall torque) 16. Motor generator (10v. input) 17. Servo motor (53/64" long) 18. Servo motor (35v. center tap) 19. Servo motor (26v. center tap) 20. Motor generator (26v. input) 21. Servo motor (.30-in-oz stall torque) 22. D.C. motor (14v. input) 23. D.C. motor (28v. input)

CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS, PA.
Sales Office: 9014 W. Chester Pike, Upper Darby, Pa.—Hilltop 9-1200, TWX Flanders, Pa. 1122

cppc

CIRCLE 83 ON READER-SERVICE CARD

MSD new literature

MICROWAVE AND Special Purpose tubes are described in new short-form 4-page catalog.—Special Tube Operations, Sylvania Electric Products, Inc., 110 Main St., Buffalo, N. Y.

CIRCLE 186 ON READER-SERVICE CARD

UHF COAXIAL Wavemeters for checking radars and other Microwave measurements, available in wavelength ranges of 2-12, 6-20 and 20-75 cm are described in 4-page catalog.—Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.

CIRCLE 187 ON READER-SERVICE CARD

TRAVELING WAVE TUBES for microwave systems, including Backward wave and Forward Wave Amplifiers and Backward Wave Oscillators, are listed in new 4-page catalog.—Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif.

CIRCLE 188 ON READER-SERVICE CARD

MINI TELEMETERY Amplifier for ac outputs of capacitive generator-type transducers and matching sub-carrier oscillators is described in 4-page folder.—Wurlitzer Co., Electronics & Defense Products Dept., No. Tonawanda, N. Y.

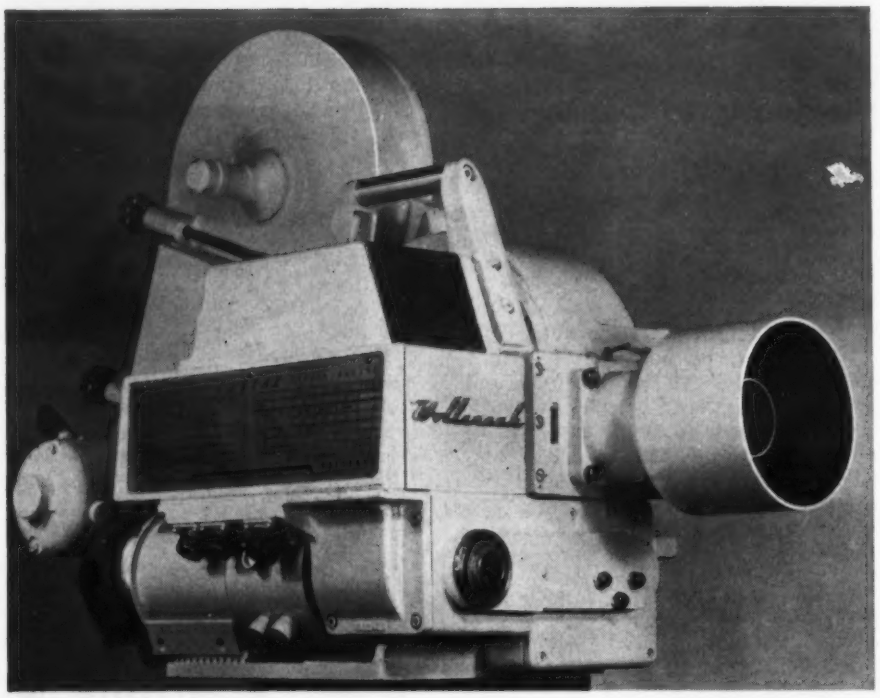
CIRCLE 189 ON READER-SERVICE CARD

STATIC COMMUTATORS and modular solid-state gating units for PAM/PDM telemetry are described with electrical and physical specifications in new 5-page bulletin.—Kinetics Corporation, 410 So. Cedros Ave., Solana Beach, Calif.

CIRCLE 190 ON READER-SERVICE CARD

MOTORS, ACTUATORS and facilities for missile and aircraft applications are described in new 36-page catalog, EE-100.—EEMCO Div., Electronic Specialty Co., 4612 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 191 ON READER-SERVICE CARD



WF-8A . . . Newest Model in *FASTAX* Family of 25 High Speed Cameras!

- Pushbutton speed selection.
- Rotating prism and high efficiency co-axial drum shutter.
- Rapid acceleration; flat speed curve within ±4% selected rate.
- Three optically projected Fiducial Markers.
- 400′ daylight magazine, standard 35mm film; negative or positive perforations.
- Thru-the-lens viewfinder . . . boresight available for metric work.
- 5⅜″ f/3.5 standard lens. Others available.

You get truly superb resolution—blur-free pictures at highest speeds—with the WF-8A 35mm Full Frame Metric High Speed Camera.

And so easy to use! No changing of motors and gears for different speeds, because unit is completely self-contained. Just load up and shoot at any of 8 speeds from 200 to 2000 p/p/s. You'll see more detail on the film than ever before . . . in full frame size!

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CIRCLE 84 ON READER-SERVICE CARD

ESAKI, VARACTOR and other new semiconductor developments are discussed in 17-page "Applications" booklet, by A. Uhlir, Jr.—Microwave Associates, Inc., Burlington, Mass.

CIRCLE 192 ON READER-SERVICE CARD

PNP SILICON ALLOY Transistors in new 200°C medium power low level amplification series meeting MIL-T-19500A are described in 4-page bulletins 2N1440, -41, -42.—National Semiconductor Corp., Danbury, Conn.

CIRCLE 193 ON READER-SERVICE CARD

MAGNETIC TRIGGERS for Silicon Controlled Rectifiers are described in new 4-page brochure on 60 and 400 cps models.—Avion Div., ACF Industries, Inc., 11 Park Place, Paramus, N. J.

CIRCLE 194 ON READER-SERVICE CARD

MECHANICAL Remote Control System for Aircraft and Missile applications is described in new 12-page catalog.—Teleflex Inc., Church Rd., No. Wales, Pa.

CIRCLE 195 ON READER-SERVICE CARD

SERVO-MECHANISM Handbook and servo system specification guide offers 40 pages of concise servo system information to design engineers.—Superior Mfg. & Instrument Corp., 154-01 Barclay Ave., Flushing 55, N. Y.

CIRCLE 196 ON READER-SERVICE CARD

RELAY MAGNETIC AMPLIFIERS for reliable control from low energy dc signals are described in 6-page technical data bulletin No. 70. Acromag, Inc., 22519 Telegraph Rd., Southfield, Mich.

CIRCLE 197 ON READER-SERVICE CARD

DIFFUSED SILICON Mesa Multipurpose NPN transistors and standard PNP types; also high voltage, fast switching, low storage and high beta NPN types are described in new 4-page folder.—Schweber Electronics, 60 Herricks Rd., Mineola, L. I., N. Y.

CIRCLE 198 ON READER-SERVICE CARD

ULTRA-LOW FREQUENCY OSCILLATORS for vibration analysis, design and test of servo-mechanisms, physical and seismological instruments, and in timing and production controls, are discussed in new 54 page catalog F.—Kron-Hite Corp., 580 Mass. Ave., Cambridge 39, Mass.

CIRCLE 199 ON READER-SERVICE CARD

TRANSISTOR SWITCHING applications are specialty of new high power NPN diffused junction silicon transistors 2N1069 and 2N1070 featuring low saturation resistances. Described in 2-page bulletin, Form 1953.—Silicon Transistor Corp., Carle Place, L. I., N. Y.

CIRCLE 200 ON READER-SERVICE CARD

TEMPERATURE ALARMS for use with standard thermostats providing protection for contents of incubators, blood banks, environmental test chambers and other temperature-controlled areas over the −90° to 400°C range, are described in 2-page brochure.—Philadelphia Scientific Glass Co., Paletown Rd., Quakertown, Pa.

CIRCLE 201 ON READER-SERVICE CARD

MINI PULSE TRANSFORMERS for blocking oscillator, pulse coupling, inverting and impedance matching are described in detail in new data sheet, Bulletin PT 160.—Valor Instruments, Inc., 13214 Crenshaw, Gardena, Calif.

CIRCLE 202 ON READER-SERVICE CARD

TRANSDUCER carrier system Series 3000 for test recording or control applications is described in new 6-page folder.—Wiancko Engineering Co., 255 N. Halstead Ave., Pasadena, Calif.

CIRCLE 203 ON READER-SERVICE CARD

MILLIMETER-WAVE components and antennas for 60-75 Kmc V-band are illustrated in 12-page catalog 160-A.—T. R. G., Inc., Microwave Dept., 9 Union Square, Somerville 43, Mass.

CIRCLE 204 ON READER-SERVICE CARD

TEST FACILITY "Party Line" Amplifier enabling any one of fifty connected microphones to be clearly understood through any of fifty connected headsets over distances of several miles, is described in 2-page technical bulletin.—Flite-Tronics, Inc., 3312 Burton Ave., Burbank, Calif.

CIRCLE 205 ON READER-SERVICE CARD

PHYSICAL FAILURE EQUATIONS are developed in 8-page paper by R. P. Haviland, Missile and Space Vehicle Dept., General Electric Co., 3198 Chestnut St., Philadelphia 4, Pa.

CIRCLE 206 ON READER-SERVICE CARD

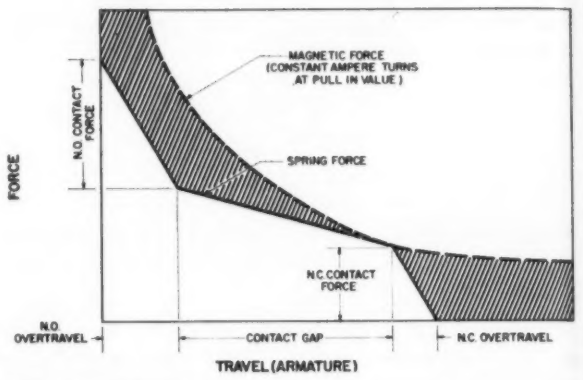
AUTOMATIC TEST equipment of complete solid-state, modular design; SCATE (Stromberg-Carlson Automatic Test Equipment) is acutal working hardware, available now. Described in 24-page brochure.—Electronics Div., Stromberg-Carlson Co., Rochester 3, N. Y.

CIRCLE 207 ON READER-SERVICE CARD

Force Function Measurements Aid Relay Design

Empirical design of relays, long the only available method of manufacturing these critical control components, has been supplanted for one manufacturer by a technique that allows reliability to be "designed into the relay."

The minute forces resulting from combinations of magnetic forces induced by current flow versus bearing friction, spring deflection, and nonlinear bending of moving contact strips have often defied careful definition, due to lack of instruments to provide the accurate force measurements needed for relay design. Now, relay specialists with the Telecomputing Corporation, Van Nuys, Calif., have developed a Force Function Machine which balances magnetic versus mechanical forces, accurately measures both and plots the two balanced forces on an electrical x-y plotter. A typical set of curves are shown from one relay study (See Figure).



RELAY DESIGN based on measurement rather than empirical factors is made possible by Force-Travel analysis.

Interpretation of the Force-vs-Travel curves enable the design engineers to accurately control contact overtravel and pressure and to control the differential of forces in order to provide safe reserves between the forces (See shaded area). Environmental and Life tests performed under MIL-Spec conditions have proved that "Engineered In" reliability has been achieved in the micro-miniature relays designed by the new technique. —(*From 4-page Brochure No.* 2.02, "*High Reliability Relay*" *Telecomputing Corporation*, 14706 *Araminta St., Van Nuys, Calif.*)

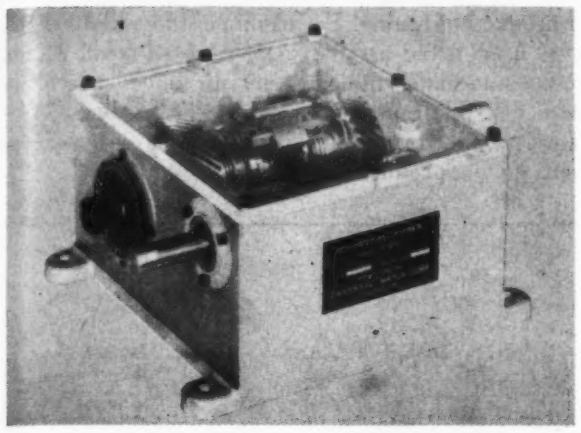
FOR THIS LITERATURE CIRCLE 208 ON READER-SERVICE CARD

BOOK REVIEW . . .

Subminiature Rate Gyroscopes, Technical Manual for Sanders Gyros. Product Manager, Subminiature Rate Gyros, Sanders Associates, Inc., 95 Canal St., Nashua, N. H., 62 p., 9″ x 11″, $2.00. Basic principles, operating characteristics, standard types, and applications design data for Sanders line of gyros are fully covered.

CIRCLE 209 ON READER-SERVICE CARD

Power Control Simplified by Mechanical Amplifier



An economical method of actuating high torque loads is offered by the Mechanical Power Amplifier, Type 69A03-1, a development of the Armament Division, Universal Match Corporation, St. Louis 35, Mo. This unit, when driven by a ¾ hp 1750 rpm electric motor or other prime mover, delivers an output of 20 lb-ft of torque at any speed up to 196 rpm in either direction of rotation—effectively taking the place of more expensive amplidynes, dc drives, power servos and their associated equipment.

Rotational direction and speed at the output shaft is a faithful reproduction, within less than 1° error, of any mechanical rotation applied to the control input shaft. Input inertia is not greater than 3.09×10^{-3} lb-in/sec^2, with input drag less than 0.1 lb-in. The control input rotation can be supplied by any form of electric, hydraulic or pneumatic control device at low torque levels.

The Mechanical Power Amplifier enables synchronous operation in many cases where the cost of synchronous motors cannot be justified. This is possible since the amplifier, within its rating, maintains its output speed independent of load variations. Variable speed control of high torque loads and transmission of position information at high torque levels are simplified by its 500:1 power amplification capability.

(*Written from fact-data sheet Type* 69A03-1 *MPA, by Avionics Dept., Armament Division, Universal Match Corp.,* 427 *Paul Ave., St. Louis* 35, *Mo.*)

FOR THIS LITERATURE CIRCLE 210 ON READER-SERVICE CARD

BOOK REVIEWS . . .

Silicon Rectifier Handbook, Audio Devices, Inc., 620 Dyer Rd., Santa Ana, Calif., 65 p, 8½" x 11", $1.00. Engineering Handbook and Catalog No. 111, January 1958.

FOR THIS LITERATURE CIRCLE 211 ON READER-SERVICE CARD

An Encyclopedic Dictionary of Electronics and Nuclear Engineering, by Robert I. Sarbacher (c1959), Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y., 1417 p., 7" x 10", $35.00. All modern terms and definitions equipments, elements, components and systems in the electronics and nuclear engineering fields are covered in alphabetical order in approximately 14,000 entries and 1,400 illustrations.

FOR THIS LITERATURE CIRCLE 212 ON READER-SERVICE CARD

EVERYTHING IN ELECTRONICS is title of 1960 edition, 522-page Catalog No. 190-A.—Allied Radio, 100 N. Western Ave., Chicago 80, Ill.

CIRCLE 213 ON READER-SERVICE CARD

VIBRATION TEST SYSTEMS for sinusoidal and random capabilities are described in Series 70 4-page bulletin #59-5.—Unholtz-Dickie Corp., 2994 Whitney Ave., Hamden 18, Conn.

CIRCLE 214 ON READER-SERVICE CARD

HYDRAULIC PUMP for supply of 500 to 5000 psi hydraulic power for missile launchers, test stands and jet starting systems is discussed in 8-page Bulletin A5232-A.—Vickers Inc., Div. of Sperry Rand Corp., Detroit 32, Mich.

CIRCLE 215 ON READER-SERVICE CARD

OPTICAL SYSTEMS and film handling devices including cameras, data reduction and display, stereoscopic systems and photogrammetric equipment are described in new 17 page booklet. —Mast Development Co., Inc., 2212 East 12th St., Davenport, Ia.

CIRCLE 216 ON READER-SERVICE CARD

SURVEYORS AND ENGINEERS Almanac, 92-page 1960 Gurley Ephemeris, includes bound-in charts for simplified computation of Polaris.—W. & L. E. Gurley, Troy, N. Y.

CIRCLE 217 ON READER-SERVICE CARD

TACHOMETERS and TEMPERATURE transducers are described in series of 2-page data bulletins.—Nacimo Products, 1090 Morena Blvd., P.O. Box 248, San Diego 10, Calif.

CIRCLE 218 ON READER-SERVICE CARD

ABLATIVE SHIELD fabrication is described in new 12-page booklet, "Development and Fabrication of High Temperature Reinforced Plastics" by CTL, 1240 Glendale-Milford Rd., Cincinnati 15, Ohio.

CIRCLE 219 ON READER-SERVICE CARD

WIRE-WOUND Micro-miniature and printed circuit resistors are immediately available are described in new 2-page bulletin.—Cinema Engineering Div., Aerovox Corp., 1100 Chestnut, Burbank, Calif.

CIRCLE 220 ON READER-SERVICE CARD

"SPECIALTY" CAPACITORS designed for specific military and commercial requirements in missiles, high-power radar, and nucleonics are described in 16-page catalog FIL-4001-59.—Filtron Co., Inc., 131-15 Fowler Ave., Flushing 55, N. Y.

CIRCLE 221 ON READER-SERVICE CARD

ELECTROLYTIC CAPACITORS for computer applications are described in new 2-page bulletin NPJ-110, Aerovox Corp., New Bedford, Mass.

CIRCLE 222 ON READER-SERVICE CARD

TIME DELAY RELAYS with solid-state timing modules are described in new 8-page Engineering Bulletin No. 5905. —Tempo Instrument Inc., P.O. Box 338, Hicksville, N. Y.

CIRCLE 223 ON READER-SERVICE CARD

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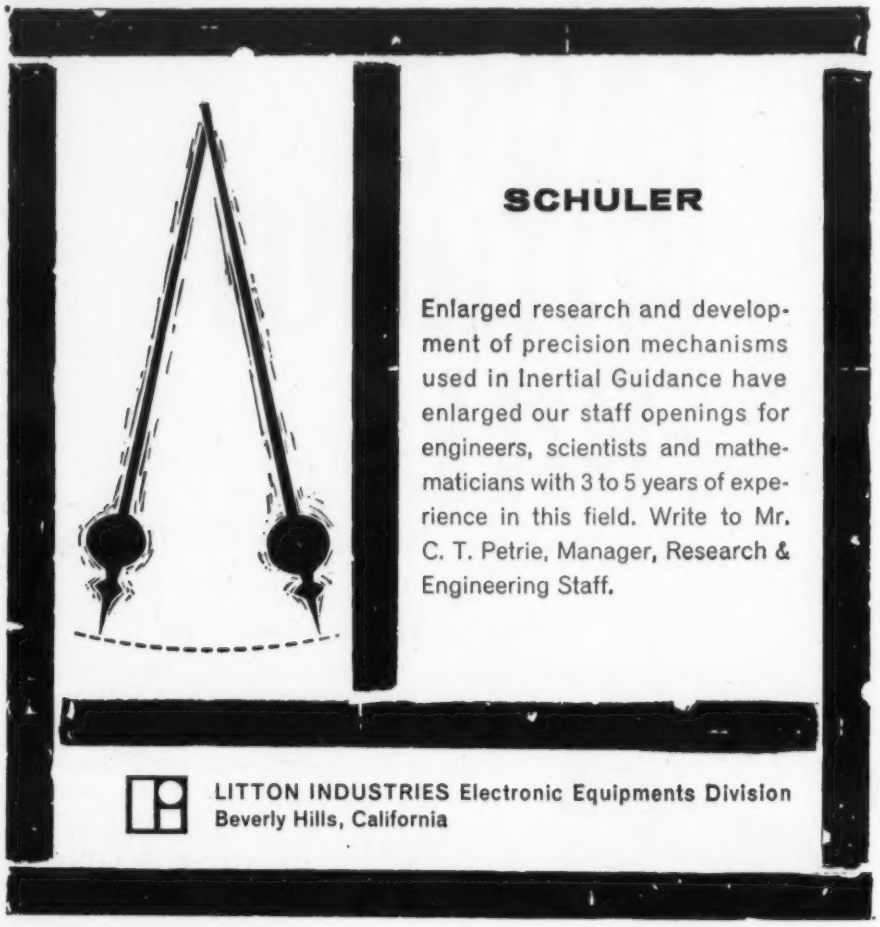

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CIRCLE 85 ON READER-SERVICE CARD

INSTANTANEOUS CIRCUIT Breakers, Series 500-I, trip in approximately 25 msec with an overload of 125% of ratings, which are given for 50 v dc, 120 v 60 cps, and 120v 400 cps types in new bulletin B-16.—Airpax Electronics, Inc., Cambridge Div., Cambridge, Md.

CIRCLE 224 ON READER-SERVICE CARD

MULTI-CONDUCTOR Control Cables, Bronco Type SO with 67.32% Neoprene Jackets, are listed in pocket catalog folder.—Western Insulated Wire Co., 2425 E. 30th St., Los Angeles 58, Calif.

CIRCLE 225 ON READER-SERVICE CARD

ELECTROHYDRAULIC Servo Valve using unity-coupled electric and hydraulic stages with hydromechanical positional feedback is technically described in new 4-page Model 6103 brochure.—Kearfott Company, Inc., Little Falls, N. J.

CIRCLE 226 ON READER-SERVICE CARD

ROTARY & LINEAR hydraulic and pneumatic actuators, servo valves and associated components for aircraft and missile use are described in new 8-page brochure.—Hydra-Power Corporation, Pine Court, New Rochelle, N. Y.

CIRCLE 227 ON READER-SERVICE CARD

NAVY CONTROL contactors, relays, starters, and other components featuring fire-resistant bases and corrosion-resistant metallic parts are listed with diagrams and prices in new Navy Control Component Catalog (GEA-6798.—General Electric Co., Schenectady 5, N. Y.

CIRCLE 228 ON READER-SERVICE CARD

CLUTCHES, BRAKES and other electromechanical items are announced in new 4-page facilities and products brochure.—Carmody Corporation, 2360 Wehrle Drive, Buffalo 21, N. Y.

CIRCLE 229 ON READER-SERVICE CARD

SYNCHRO SIZE 8 Component specifications for torque receivers, transmitters, control transformers, resolvers, etc., are listed in new Bulletin 204.—Induction Motors of California, 6058 Walker Ave., Maywood, Calif.

CIRCLE 230 ON READER-SERVICE CARD

SOLENOIDS & SOLENOID VALVES for missile fuel and hydraulic ordnance, aircraft and general purpose applications are described in 4-page brochure.—Koontz-Wagner Electric Co., Inc., 516 N. Michigan St., South Bend 1, Ind.

CIRCLE 231 ON READER-SERVICE CARD

ACTUATOR SYSTEM Terminology section which explains technical terms used in actuator literature is feature of new 26-page catalog of modular and custom-engineered electromechanical actuators.—Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.

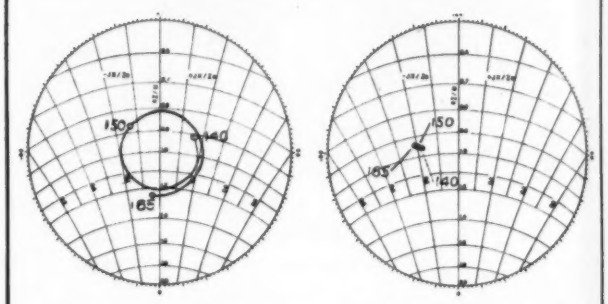
CIRCLE 232 ON READER-SERVICE CARD

PRECISE-POWER Systems, consisting of rotary electromechanical power system usually controlled and/or regulated by static circuitry, are described in new 32-page bulletin.—Electric Specialty Co., 211 South St., Stamford, Conn.

CIRCLE 233 ON READER-SERVICE CARD

RF Production Measurements

Because of the simplicity in their operation, ACMI Automatic Impedance Plotters are particularly useful in production testing. For example, these plotters have been used to adjust the impedance of loads so that they would match the characteristic impedance of uniform coaxial transmission lines within about 1½%. They are also used to make adjustments of RF components during production tests.



View A - Impedance of assembly No. 1

View B - Impedance of assembly No. 2

View C - VSWR of assembly No. 1

View D - VSWR of assembly No. 2

IMPEDANCE and VSWR curves of cable assemblies No. 1 and No. 2.

Impedance information is delivered as an oscilloscope trace viewed through a transparent Smith Chart or a trace made by an X-Y plotter on a Smith Chart (See Figure). Sixty points can be plotted every second, enabling the behavior of an unknown impedance to be explored over a 1.4 to 1 frequency band in a fraction of a minute; and over a 10 to 1 frequency range, in one to several minutes.

Impedance curves show more useful information than corresponding VSWR curves. Assembly No. 1 in this example is a 20-ft FR cable terminated by a good 50-ohm load. The connector at this load has too much capacitance. Assembly No. 2 (similar cable and load) has a faulty connector at the end farthest from the load. Although the VSWR curves of the two assemblies are identical, the location of the fault is at once apparent from the impedance plots.—(*From* 50-*page Catalog* E-1959, *Instruments and Components, Alford Manufacturing Co.*, 299 *Atlantic Ave., Boston, Mass.*)

FOR THIS LITERATURE CIRCLE 234 ON READER-SERVICE CARD

INDEX TO 1959

An index to the 1959 issue of Military Systems Design will be included in the March-April, 1960 issue.

MSD advertisers' index

CIRC E 86 ON READER-SERVICE CARD →

ABSOLUTE MAXIMUM RATINGS AT 25°C

Forward Current	I_f	50 mA
Minimum Breakover Voltage	V_{bo}	TSW-30 30V; TSW-60 60V
Reverse Breakdown Voltage	V_r	TSW-30 30V; TSW-60 60V
Storage Temperature		−65°C to 150°C
Ambient Temperature Range		−55°C to +125°C

SPECIFICATIONS AND TYPICAL CHARACTERISTICS
(At 25°C Unless Otherwise Stated)

		Typical	Max.	Test Conditions	
Saturation Voltage	V_S	1.0	1.5	Volts	$I_C = 50$ mA
Forward Leakage Current	I_F	0.1	10	μA	$V_C = 30V$
Reverse Leakage Current	I_R	0.1	10	μA	$V_C = -30V$
Forward Leakage Current	I_F	20.	50.	μA	at 125°C
Reverse Leakage Current	I_R	20.	50.	μA	at 125°C
Gate Voltage to Switch "ON"	V_g On	0.7	1.0	Volts	$R_L = 1K$
Gate Current to Switch "ON"	I_g On	0.1	1.0	mA	$R_L = 1K$
Gate Voltage to Switch "OFF"	V_g Off	1.2	4.0	Volts	$I_C = 50$ mA
Gate Current to Switch "OFF"	I_g Off	7.0	10.	mA	$I_C = 50$ mA
Holding Current	I_H	2.0	5.0	mA	$R_L = 1K$

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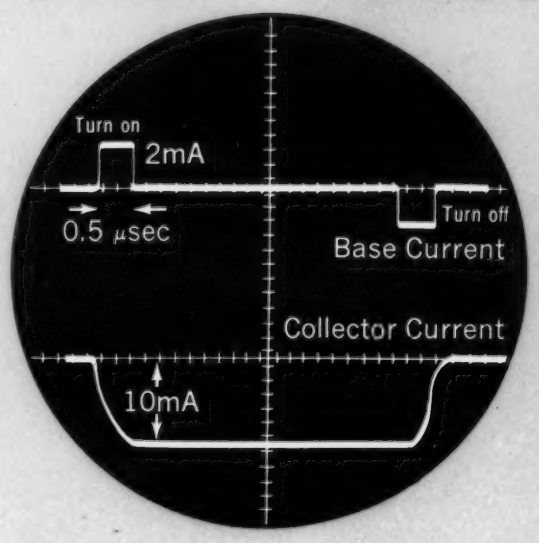

The TRANSWITCH is a new bistable silicon device that can be TURNED OFF with gate current.

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◄ MODEL 1515A
I-15VDC • 0-1.5A
$174.50

◄ MODEL 3206
I-32VDC • 0-600MA
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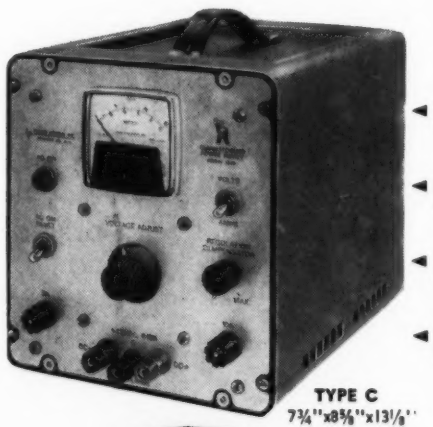
is a transistorized circuit continuously monitoring dissipation in the series power transistors of the regulator system. Dissipation above a preset maximum value is automatically transferred into external vitreous enamel resistors extending from the rear of the equipment in a perforated metal cage. "HEATRAN" thus permits fewer transistors for a given power supply capacity, more compact equipment with increased reliability and practical convection cooling.



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I-12VDC • 0-10A
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REGULATION: .05%
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All Others—.01 ohms

TYPE C
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VOLTRAN †

is a transistorized circuit continuously monitoring the voltage drop in the series power transistors of the regulator system. Voltages above a preset maximum are instantaneously absorbed thus protecting these transistors against line and load transients and permitting more conservative voltage derating.

†U.S. Pat. Applied For

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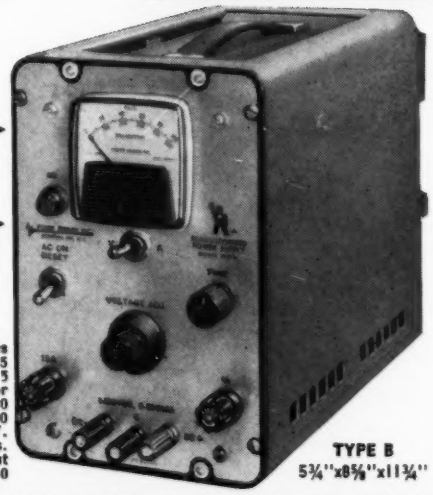

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MSD events

March 14—Dynamics Digital Module Applications Symposium, Beverly Hilton Hotel, Beverly Hills, Calif., Sponsored by Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif. For details write Dawn Walker, above address.

March 21-24—IRE National Convention, Coliseum and Waldorf-Astoria Hotel, New York, N. Y. Write E. K. Gannett, Institute of Radio Engineers, 1 East 79th St., New York 21, N. Y.

March 24-25—1st Annual Symposium, Human Factors in Electronics, Auditorium of Bell Telephone Laboratories, 463 West St., New York, N. Y., Sponsored by PGHFE-IRE Advance Registration, write K. G. Van Wynen, Chairman Local Arrangements, Bell Tel. Labs, Room 628A, 463 West St., New York, N. Y.

April 12-13—Static Relay Symposium, Hexagon Auditorium, U. S. Army Signal Research & Development Lab., Ft. Monmouth, N. J. Write Mr. Wm. J. Fontana, SIGFM/ELPEE, USA Signal R & D Lab., Ft. Monmouth, N. J.

April 19-21—10th Annual Symposium of Active Networks and Feedback Systems, Engineering Societies Bldg., 33 W. 39th St., New York. Microwave Research Institute of Polytechnic Institute of Brooklyn.

May 2-4—NAECON (12th National Aeronautical Electronics Conference) Biltmore and Miami-Pick Hotels, Dayton, Ohio. Sponsored by Dayton Section IRE and PGANE-IRE, Write J. S. Horrigan, Publicity, 5387 Maple Cliff Ct., Dayton 15, Ohio.

June 16-18—Fifth Annual Symposium and Exhibit of the American Scientific Glassblowers Society, Penn-Sheraton Hotel, Pittsburgh, Pa. Twenty papers will be presented in five sessions by nationally recognized authorities in the glasss-working field. Write to W. E. Barr, Gulf Research & Development Co., P. O. Box 2038, Pittsburgh 20, Pa.